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Choi et al.

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(54) **LIQUID CRYSTAL DISPLAY DEVICE INCLUDING A TRANSFLECTOR AND A BACKLIGHT BETWEEN TWO LIQUID CRYSTAL DISPLAY PANELS**

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(52) **U.S. Cl.** **349/74**; 349/61; 349/62; 349/114

(58) **Field of Search** 349/61, 62, 65, 349/73, 74, 113, 114

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(57) **ABSTRACT**

Disclosed is an LCD device for performing bi-directional display. The LCD device includes first and second display units, and a light supplying unit. The first display unit includes an LCD panel and a transflective film that is disposed under the LCD panel and has layers in which first and second layers having different refractivity indexes are alternately stacked. The transflective film partially reflects and transmits light incident onto the film. The light supplying unit is disposed between the first and second display units, and provide the first and second display units with light generated from a lamp by dividing the light, to thereby regulate a contrast ratio of a luminance between the first and second display units. Therefore, the structure of an LCD panel for performing bi-directional image display can be simplified, and the light loss in the transmission mode can be reduced.

33 Claims, 20 Drawing Sheets

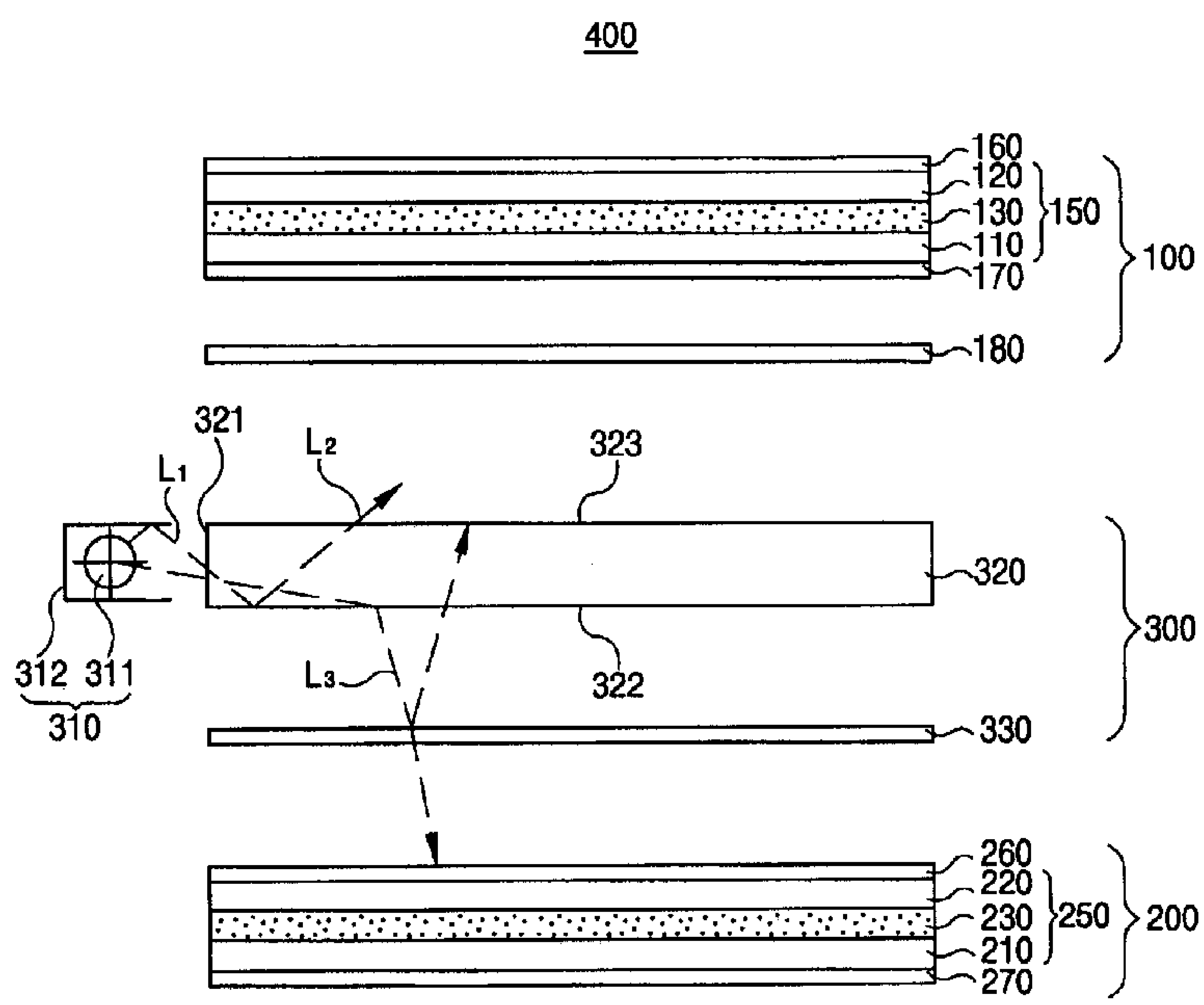
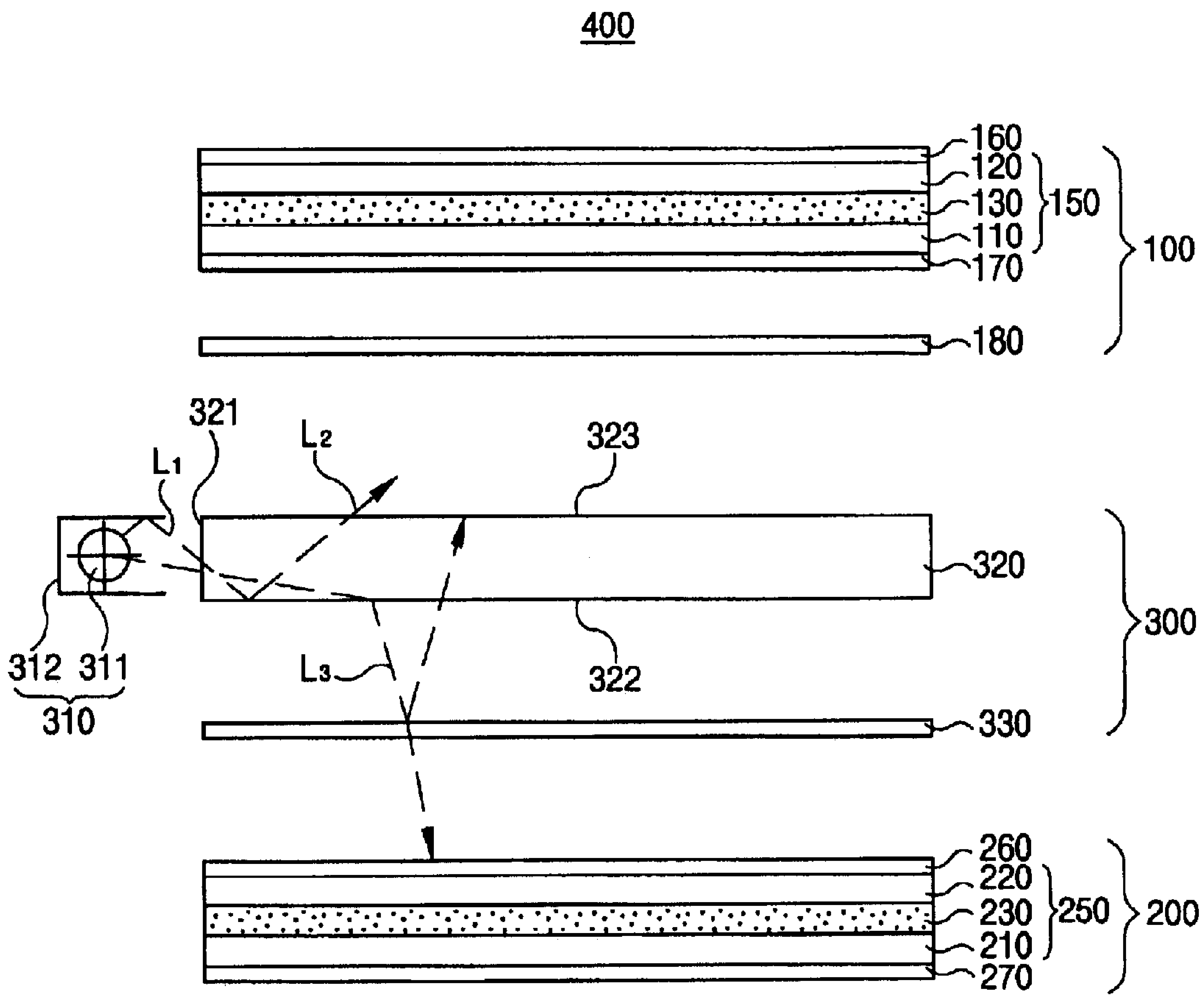


FIG.1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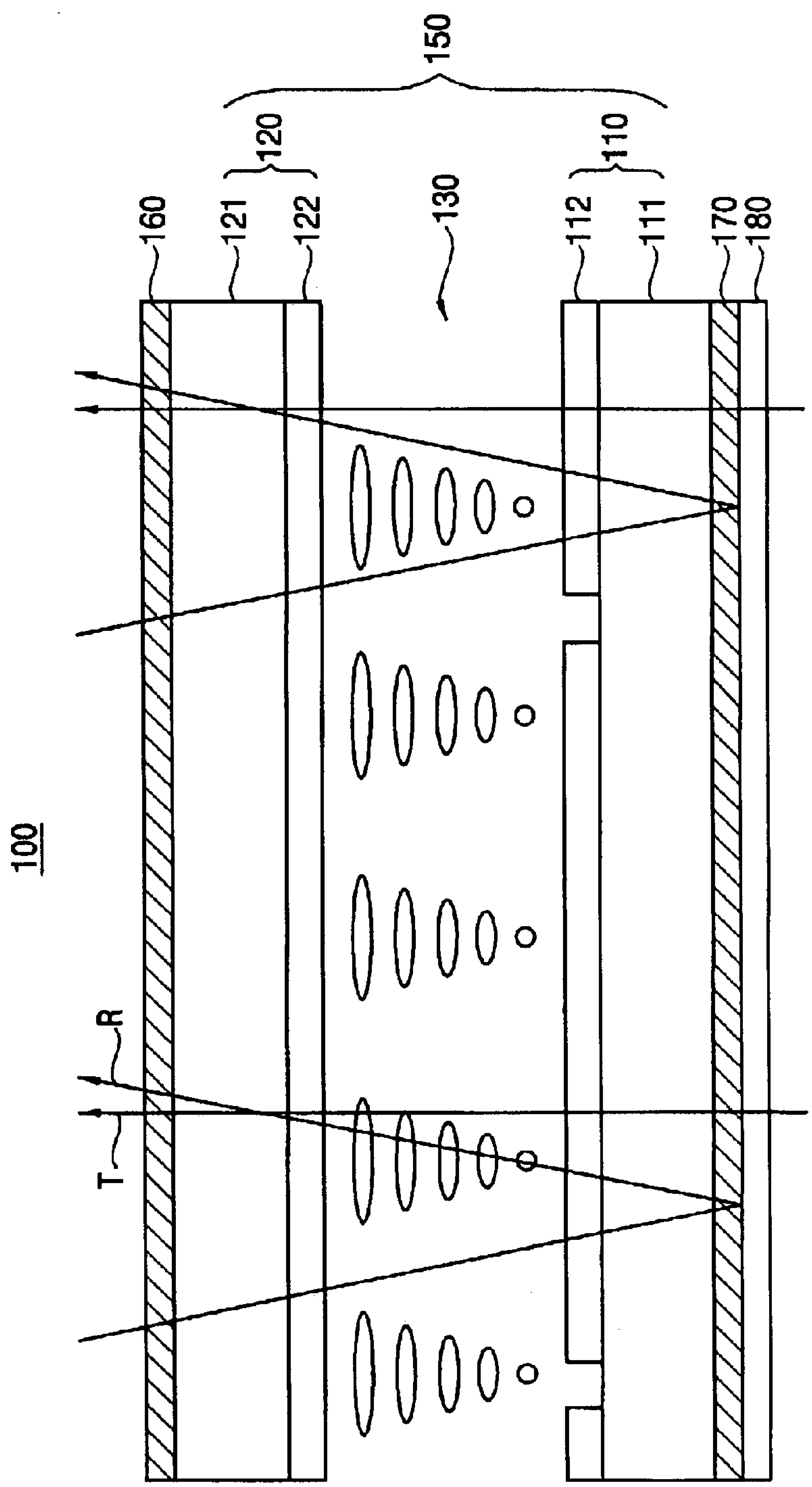

FIG.2

FIG.3

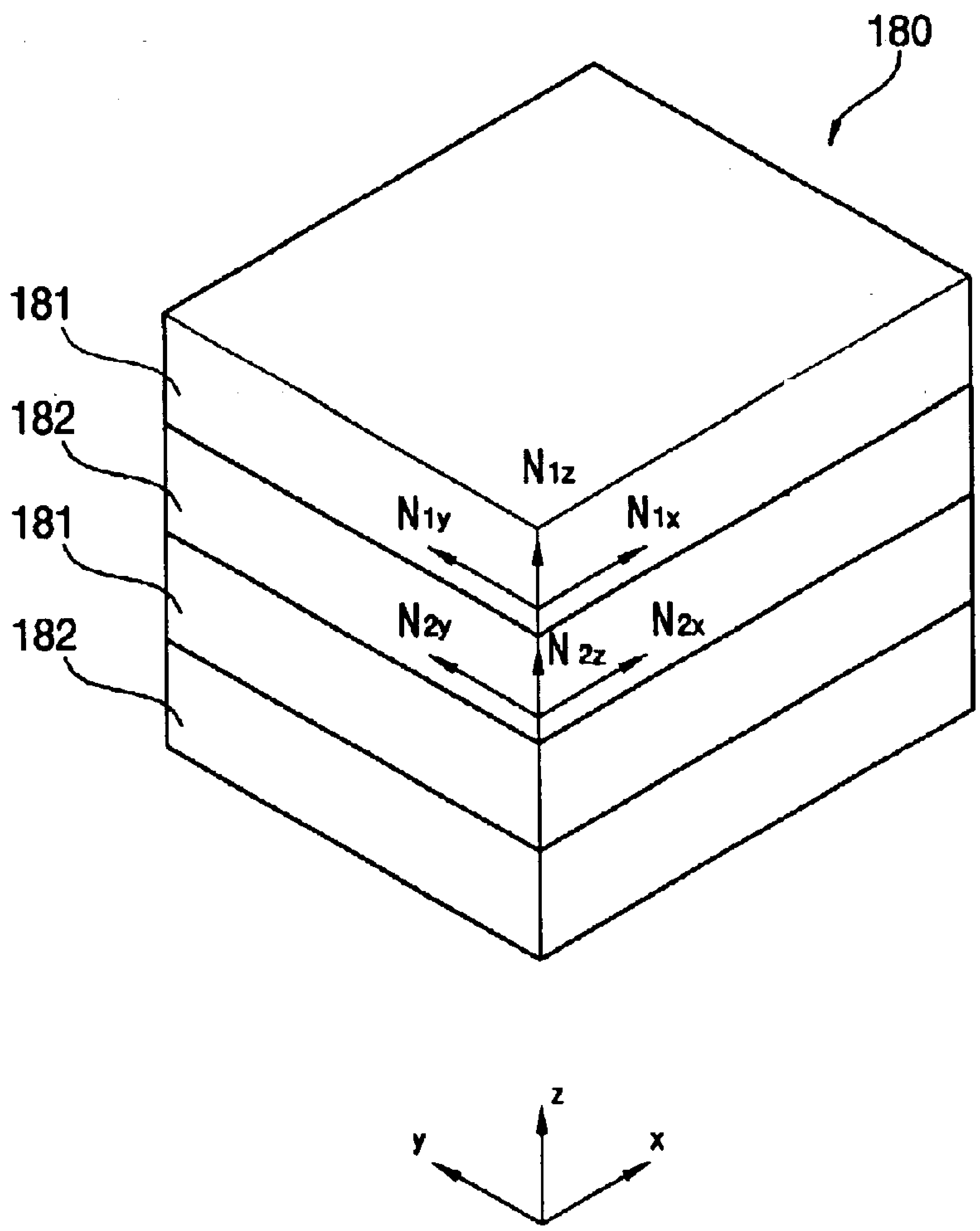

FIG.4A

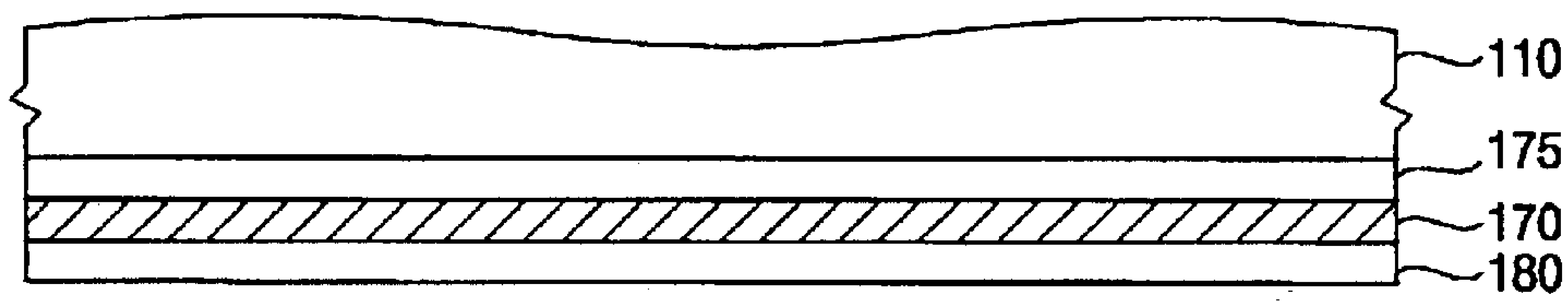

FIG.4B

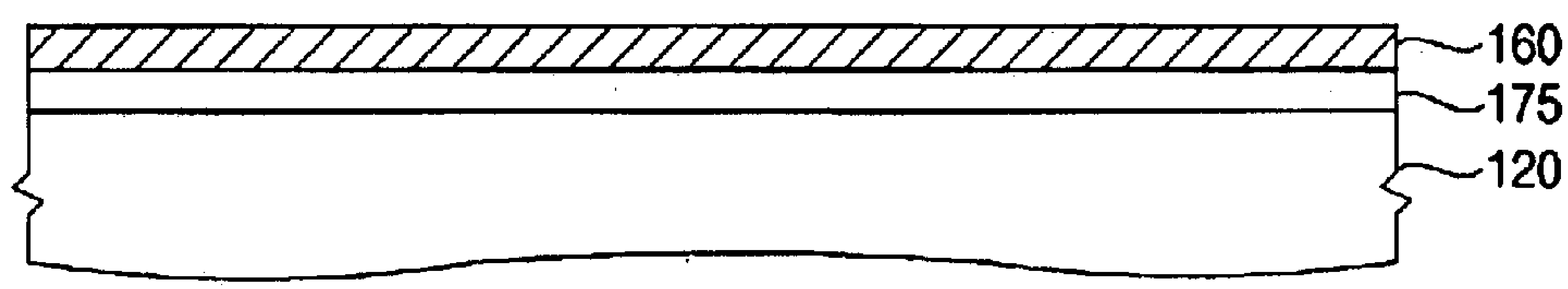

FIG.4C

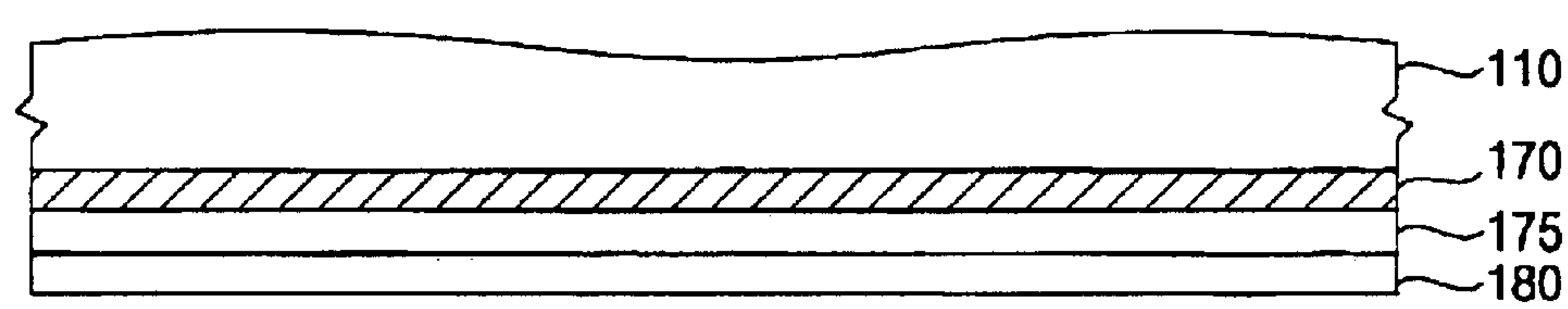

FIG.5A

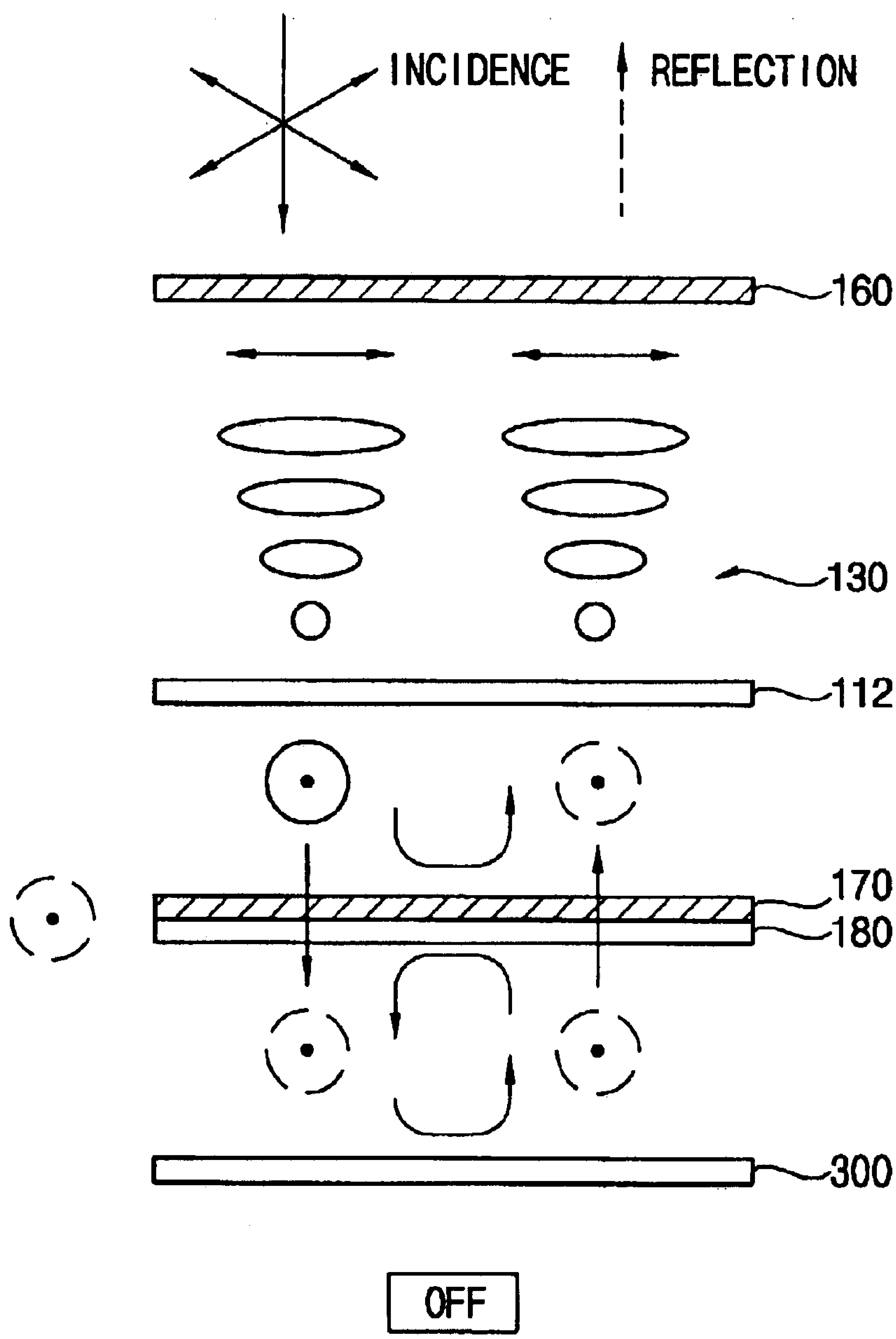

FIG.5B

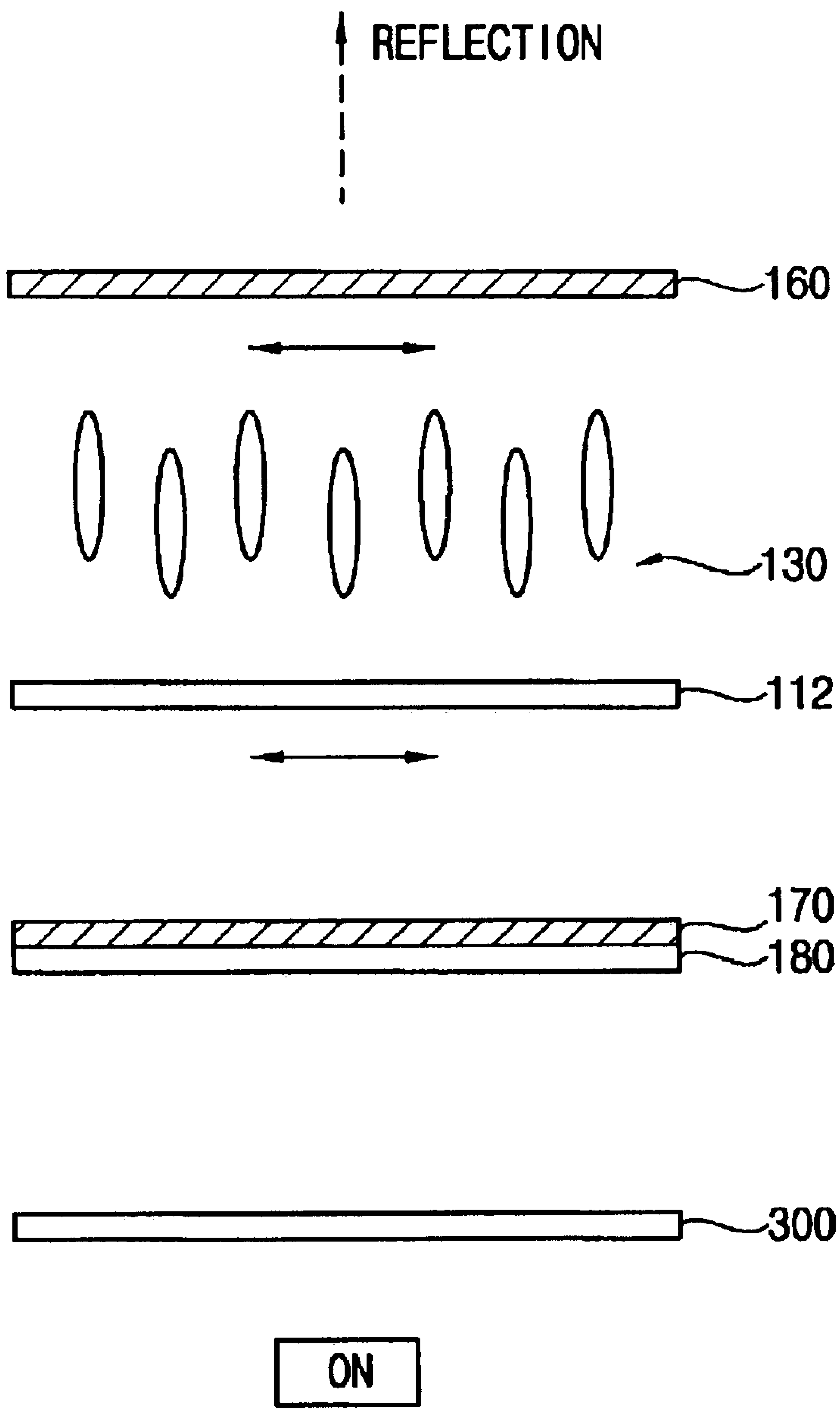

FIG.6A

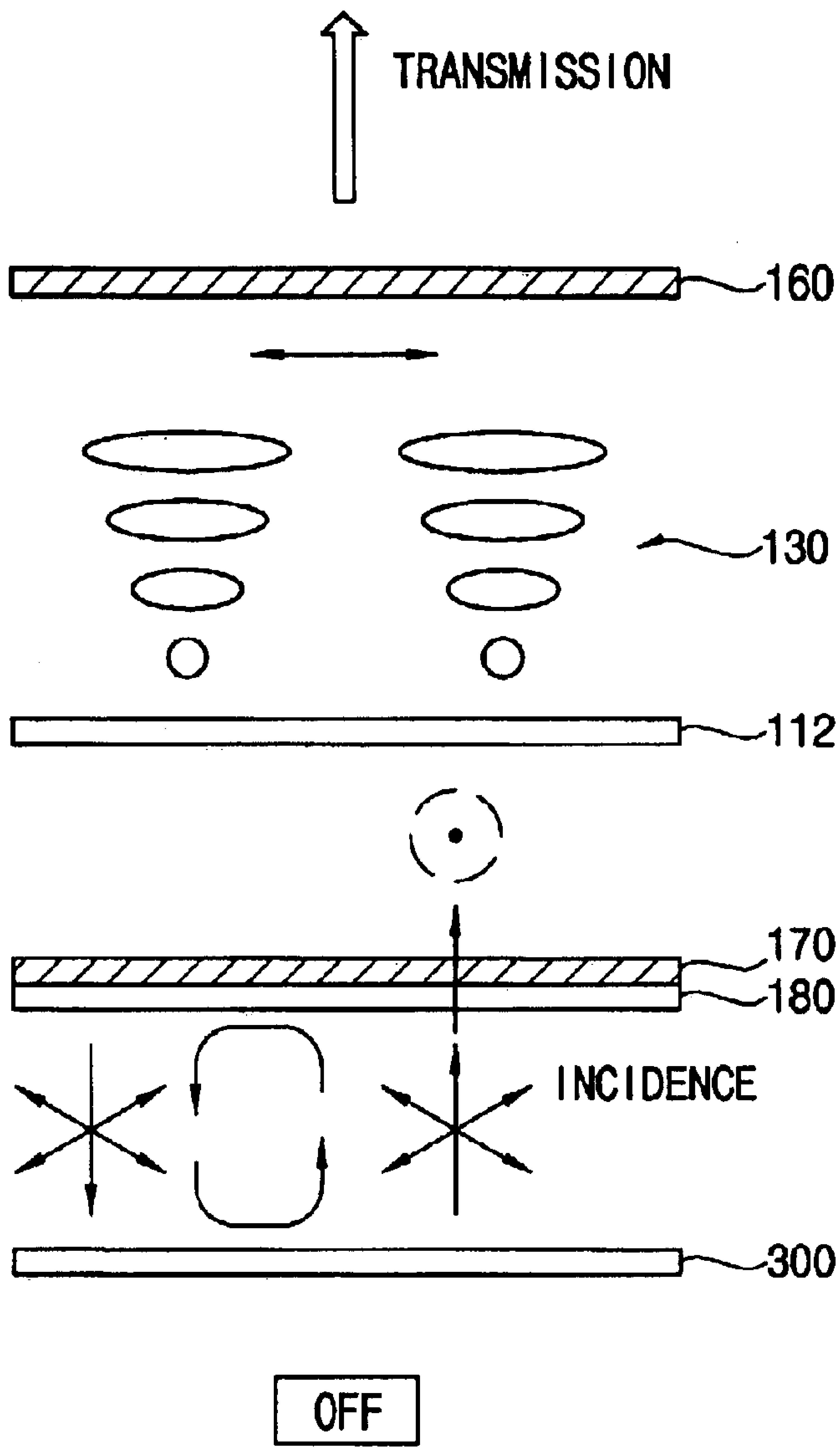

FIG.6B

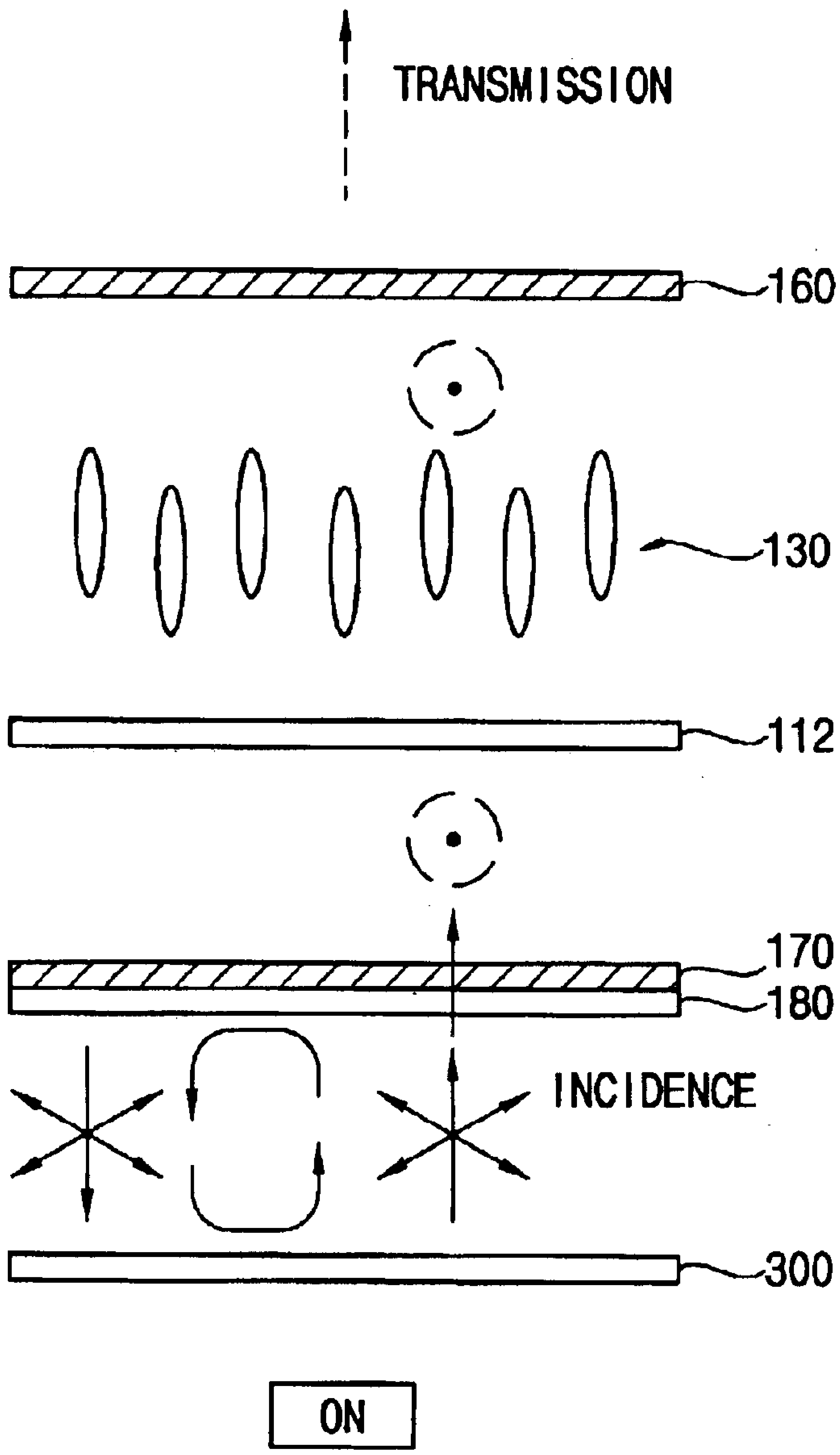

FIG.7A

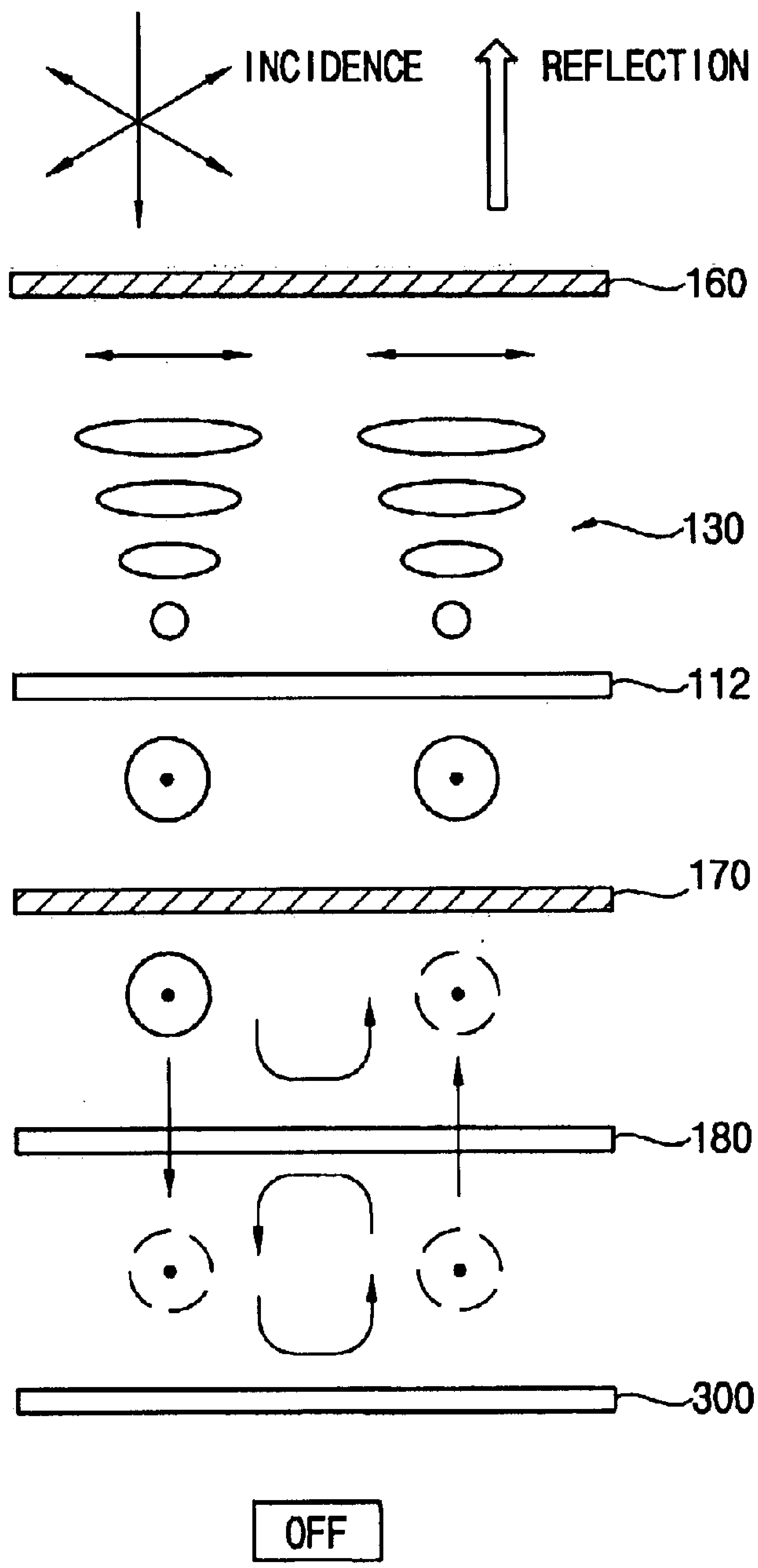

FIG. 7B

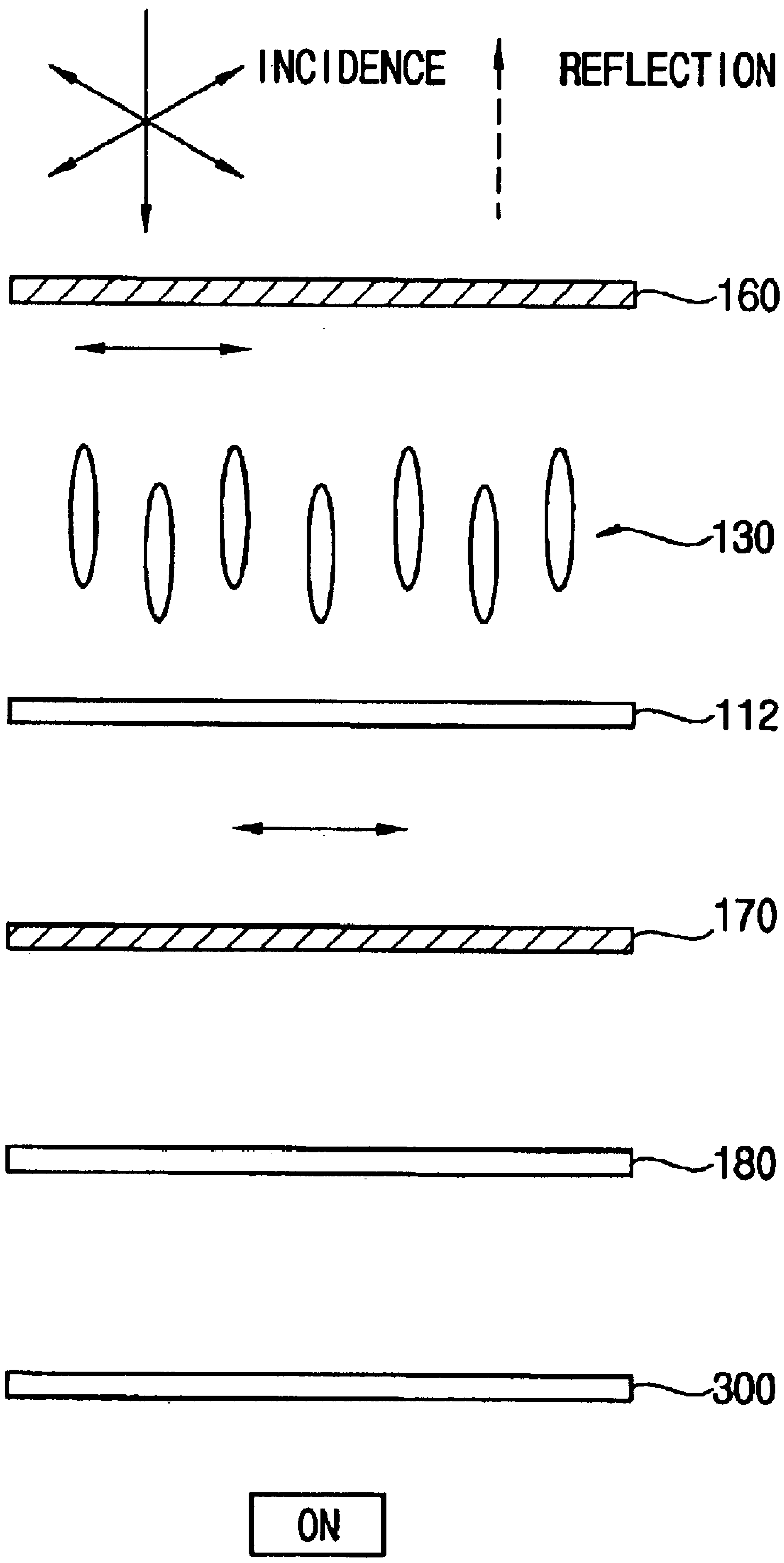

FIG.8A

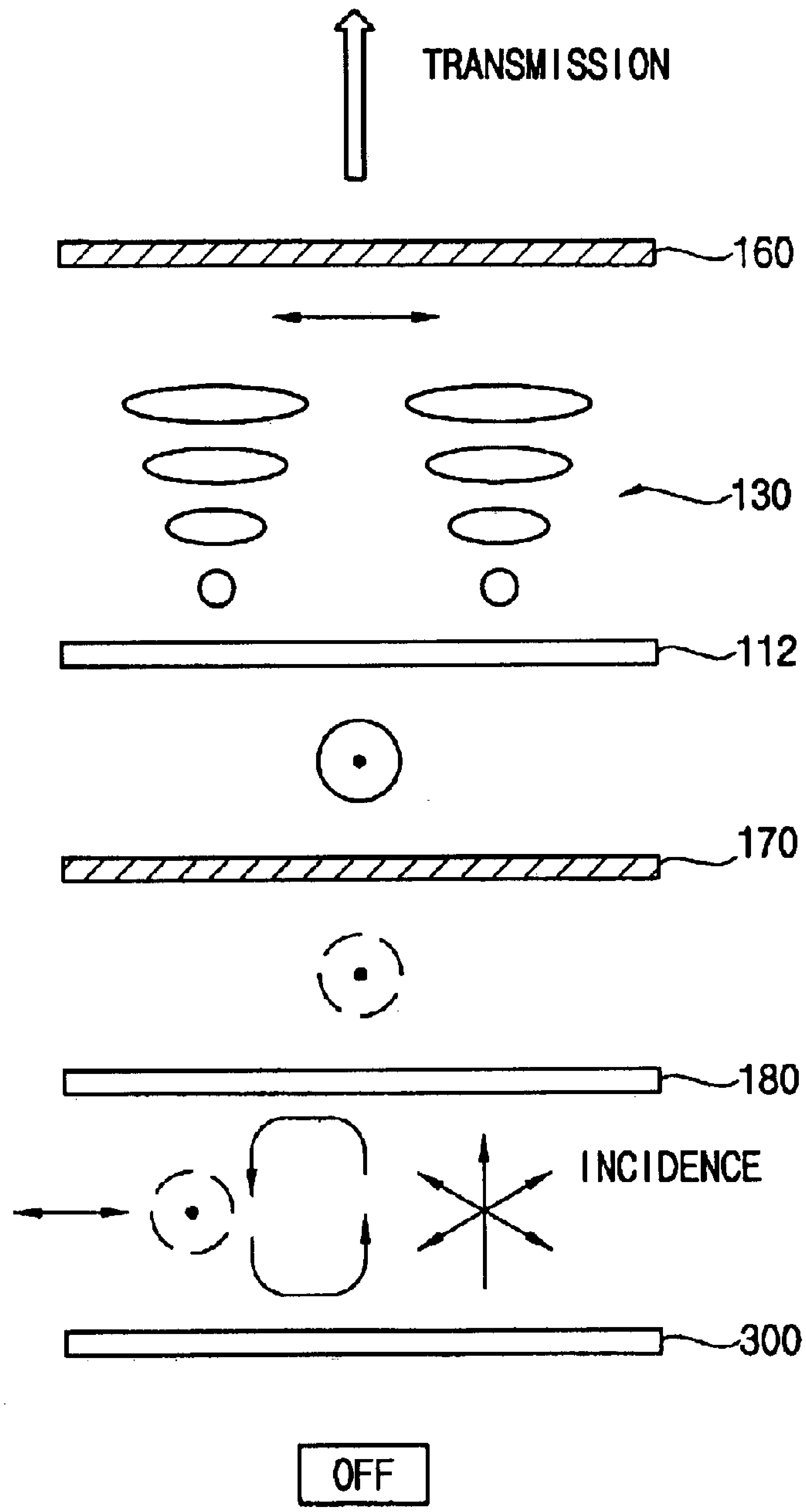

FIG.8B

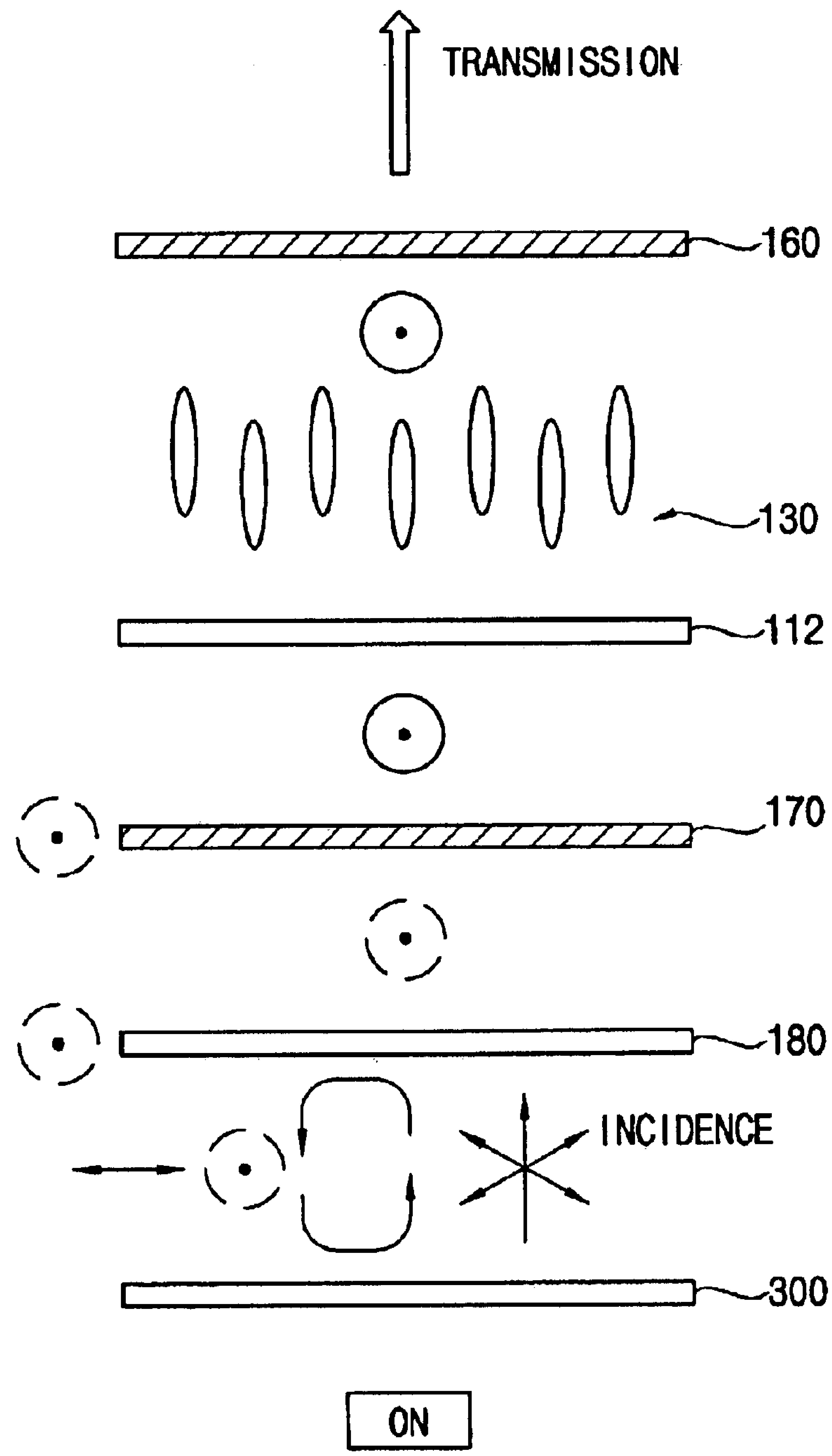

FIG.9

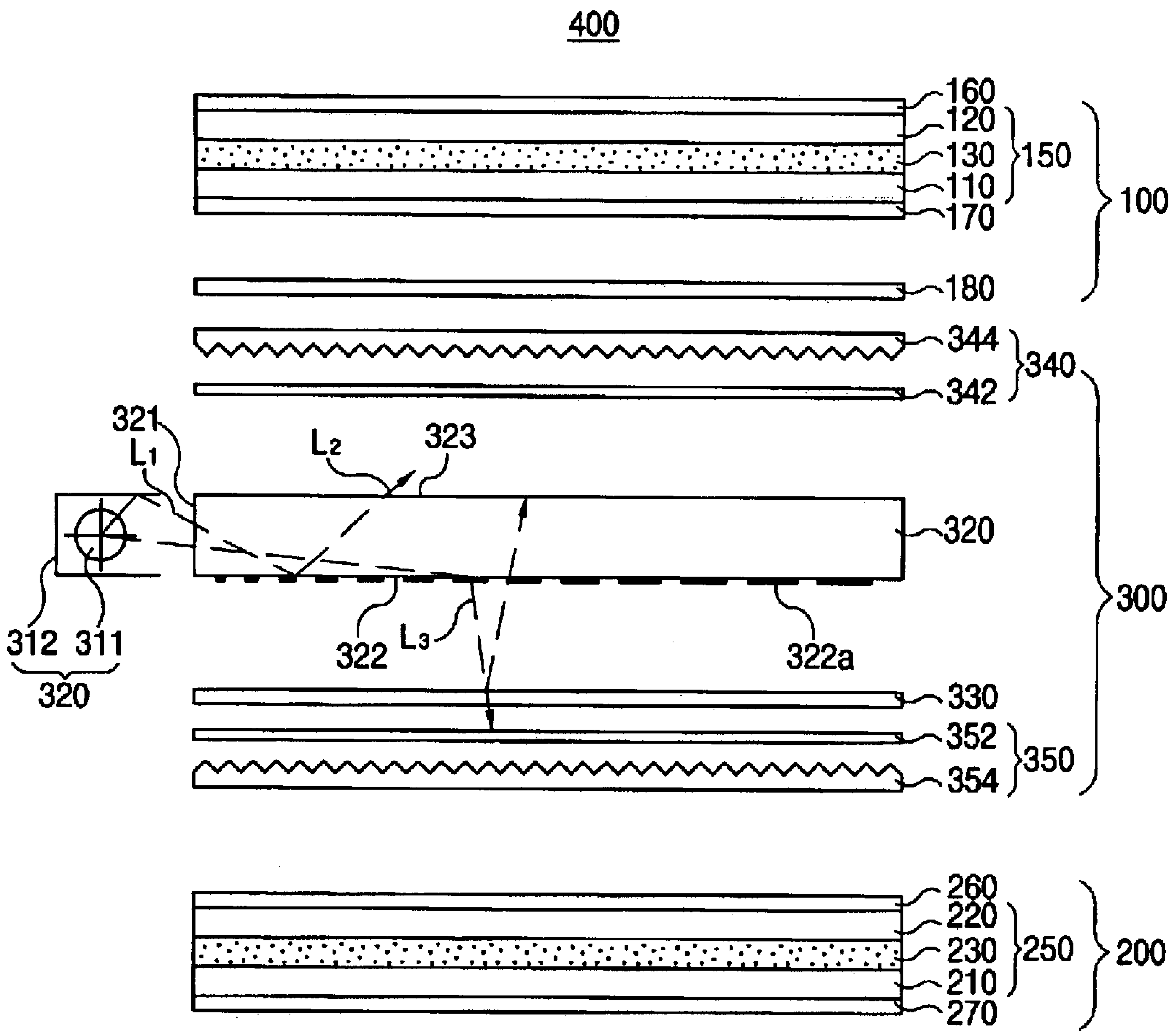

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FIG.10

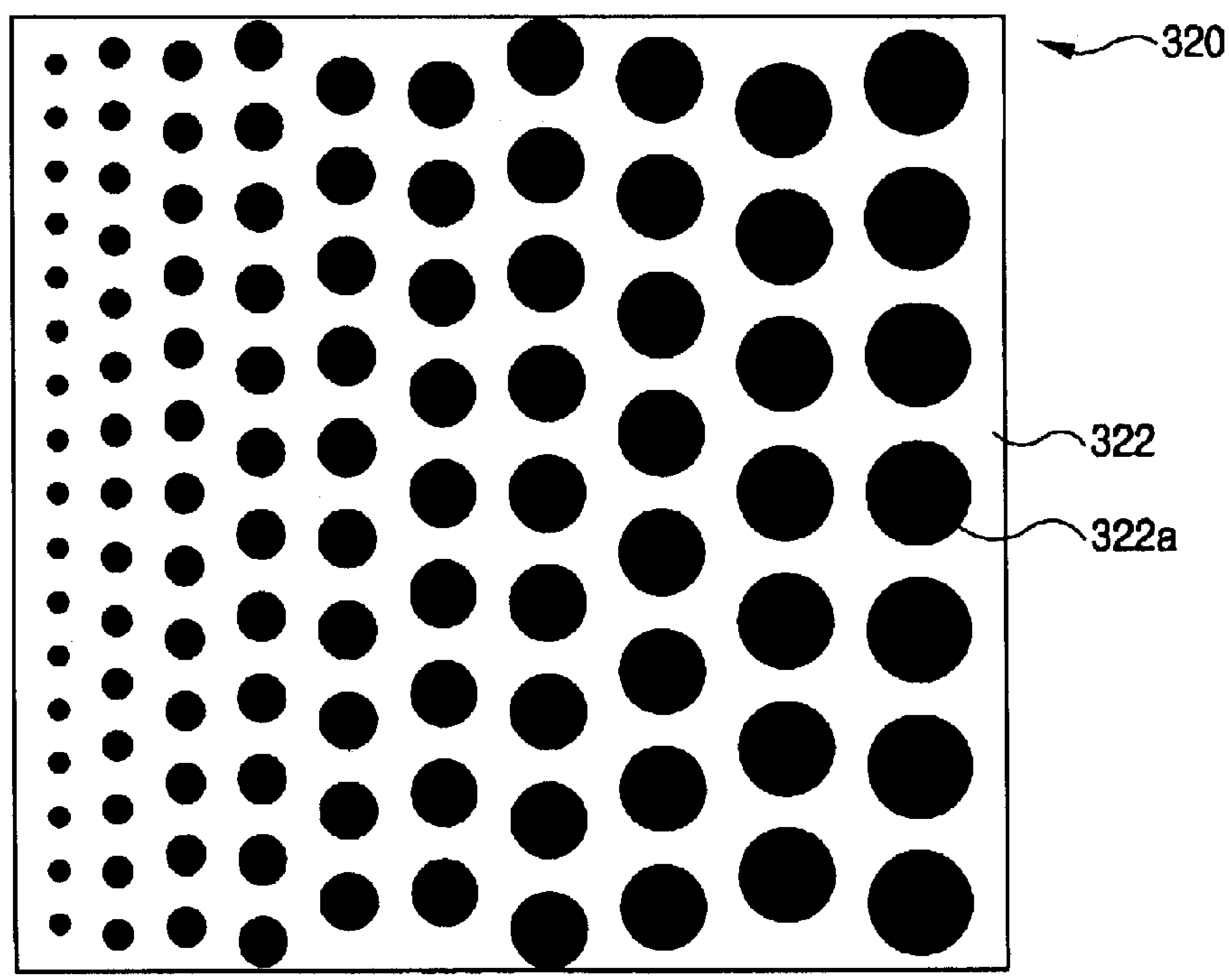

FIG.11

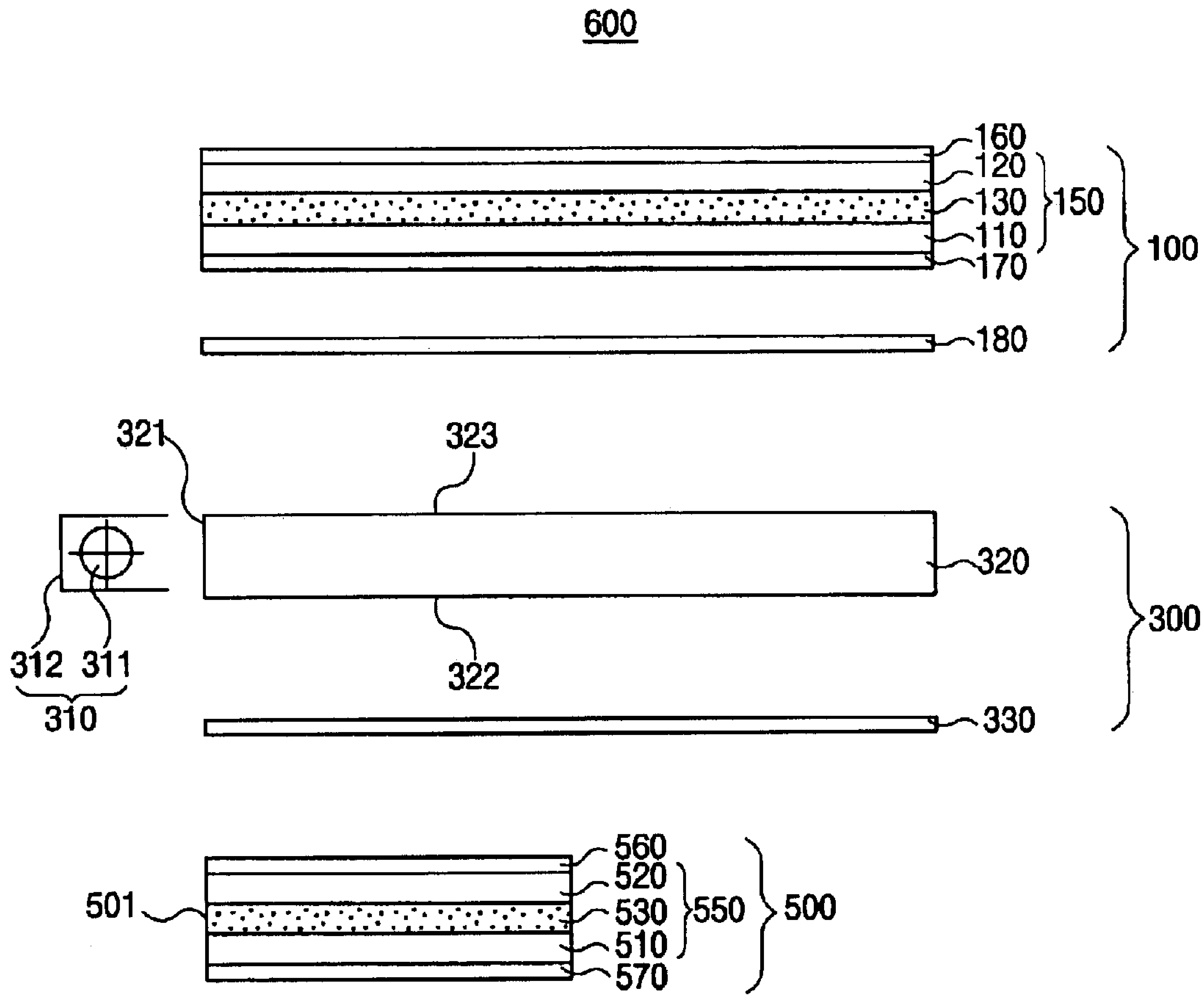
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FIG.12

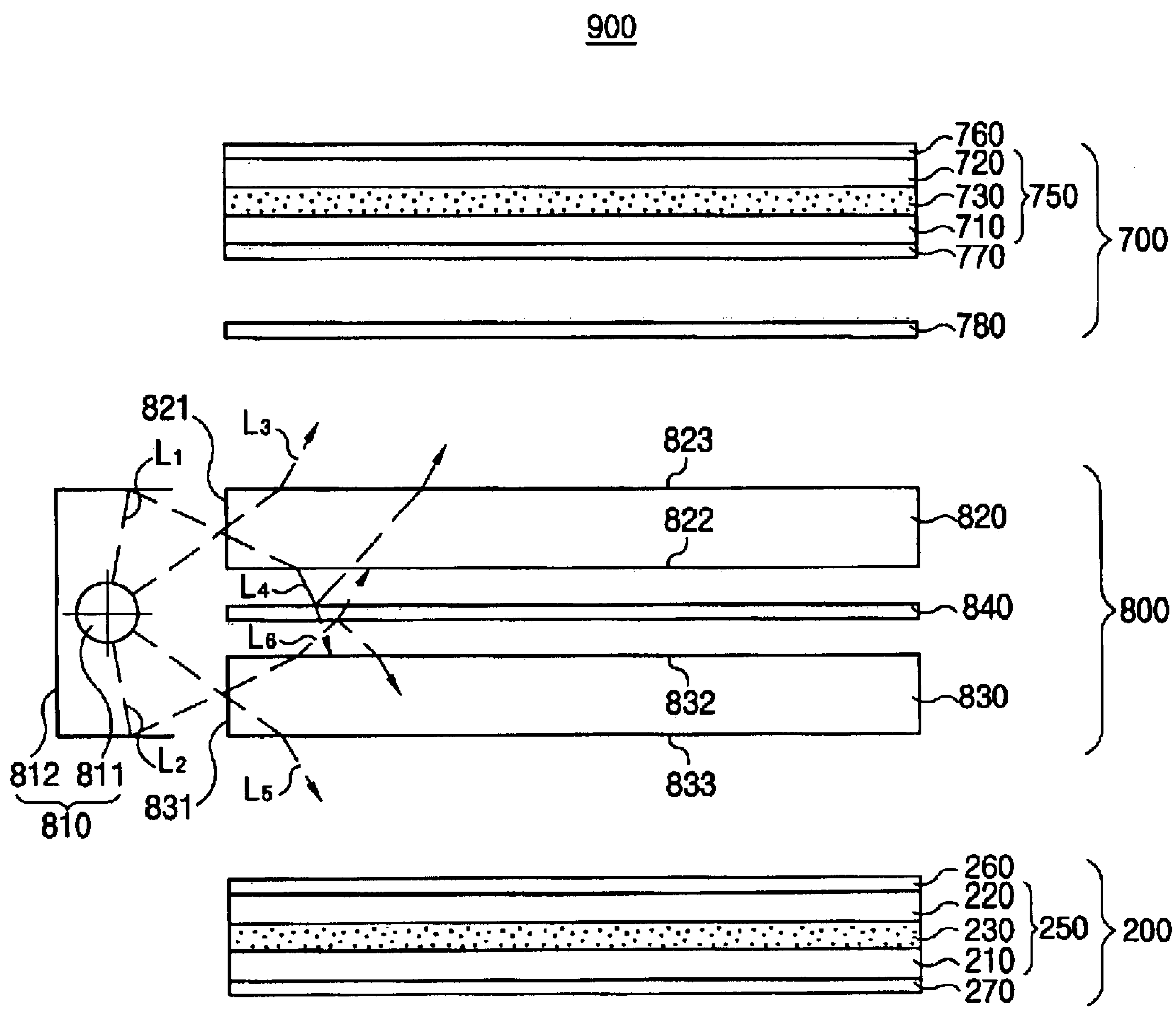
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FIG.13

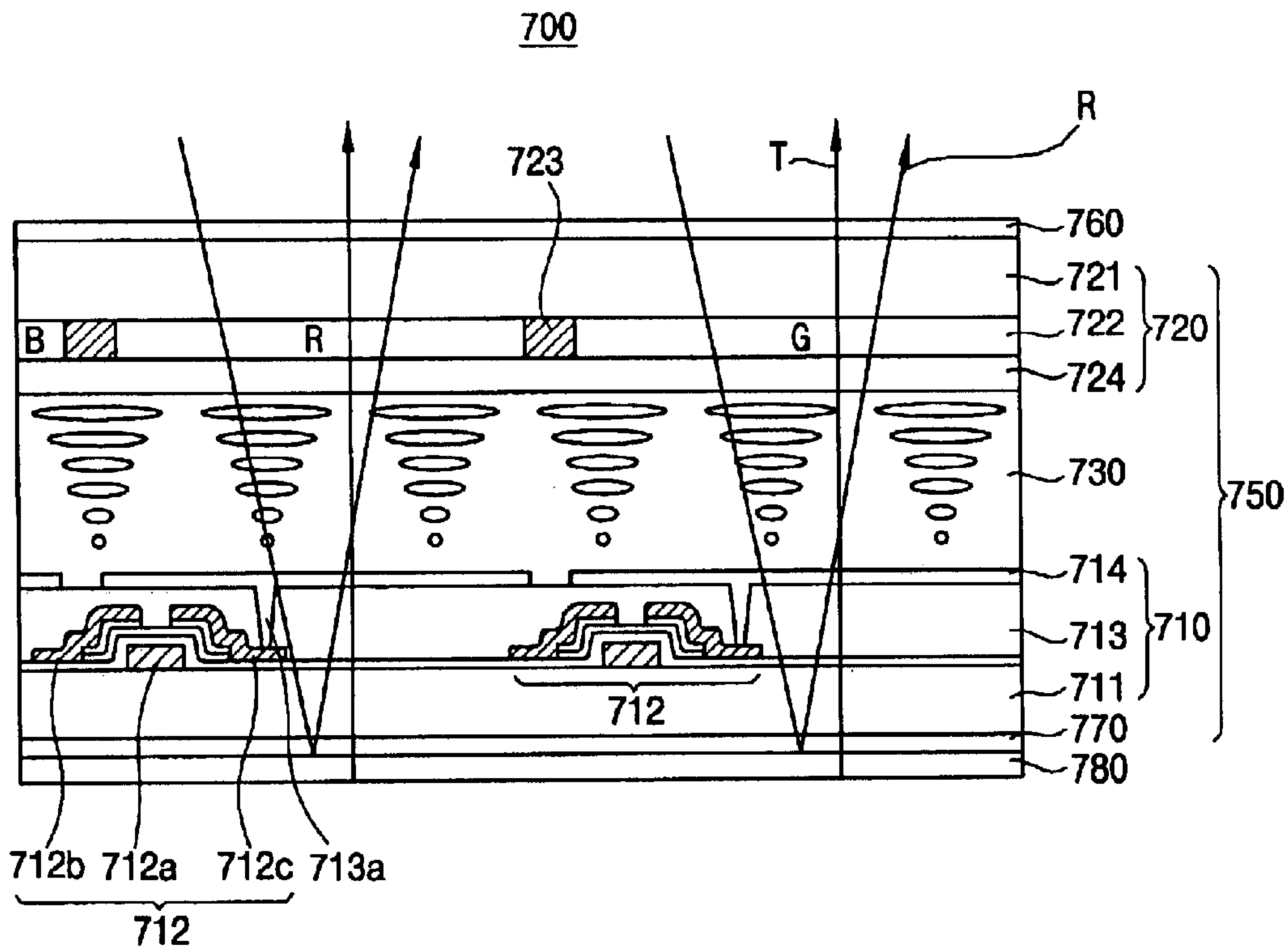
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FIG.14

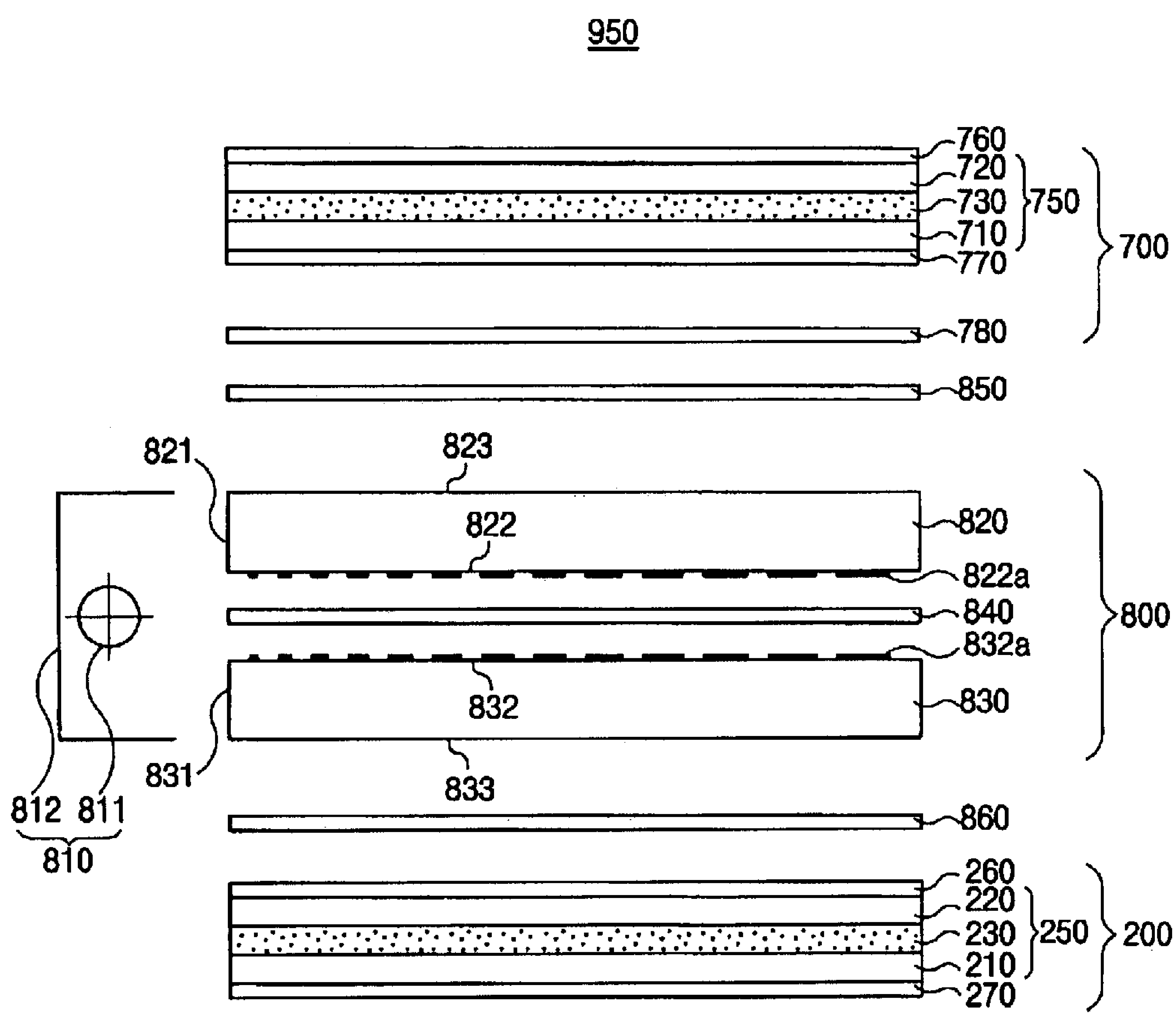
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FIG.15

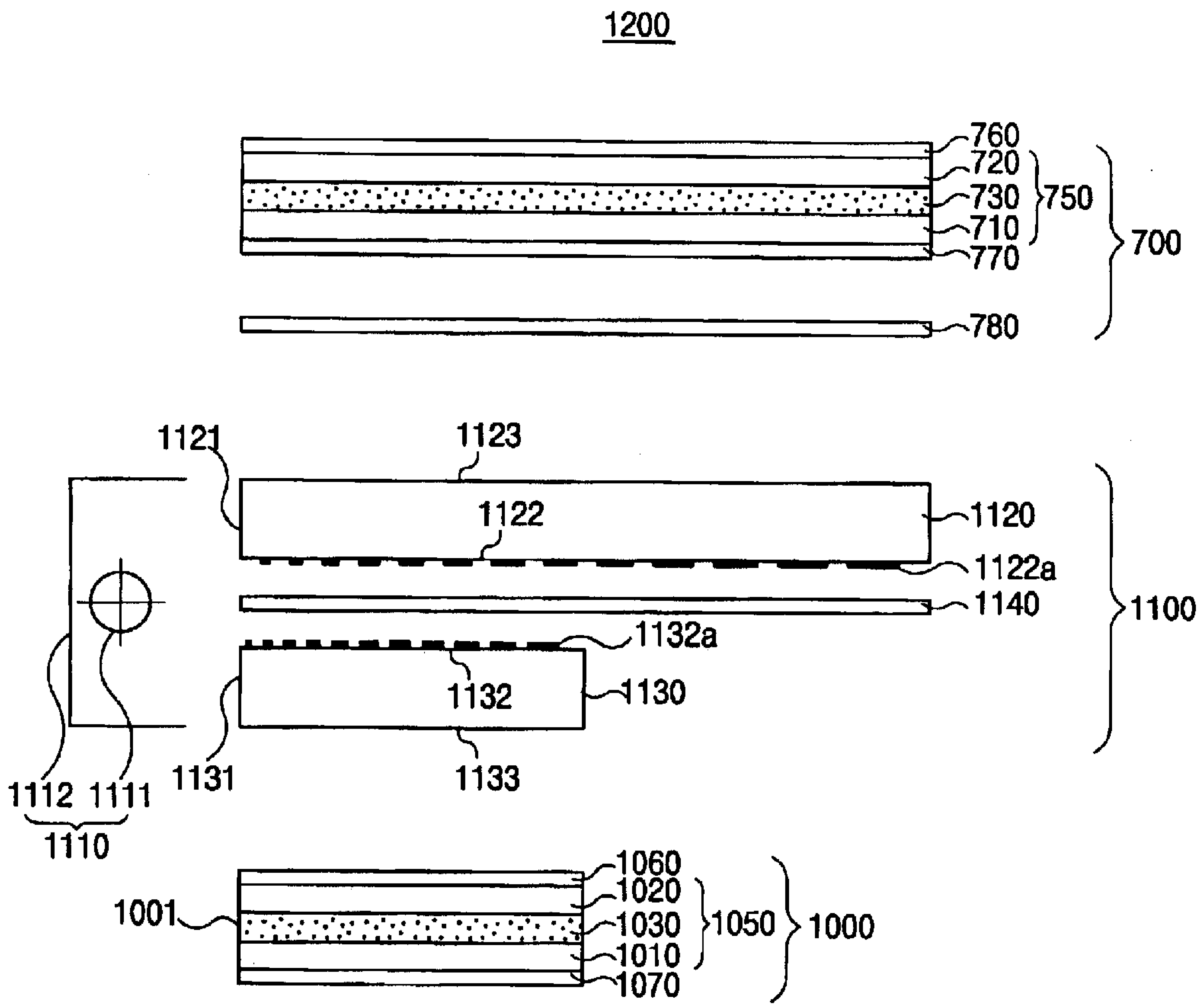
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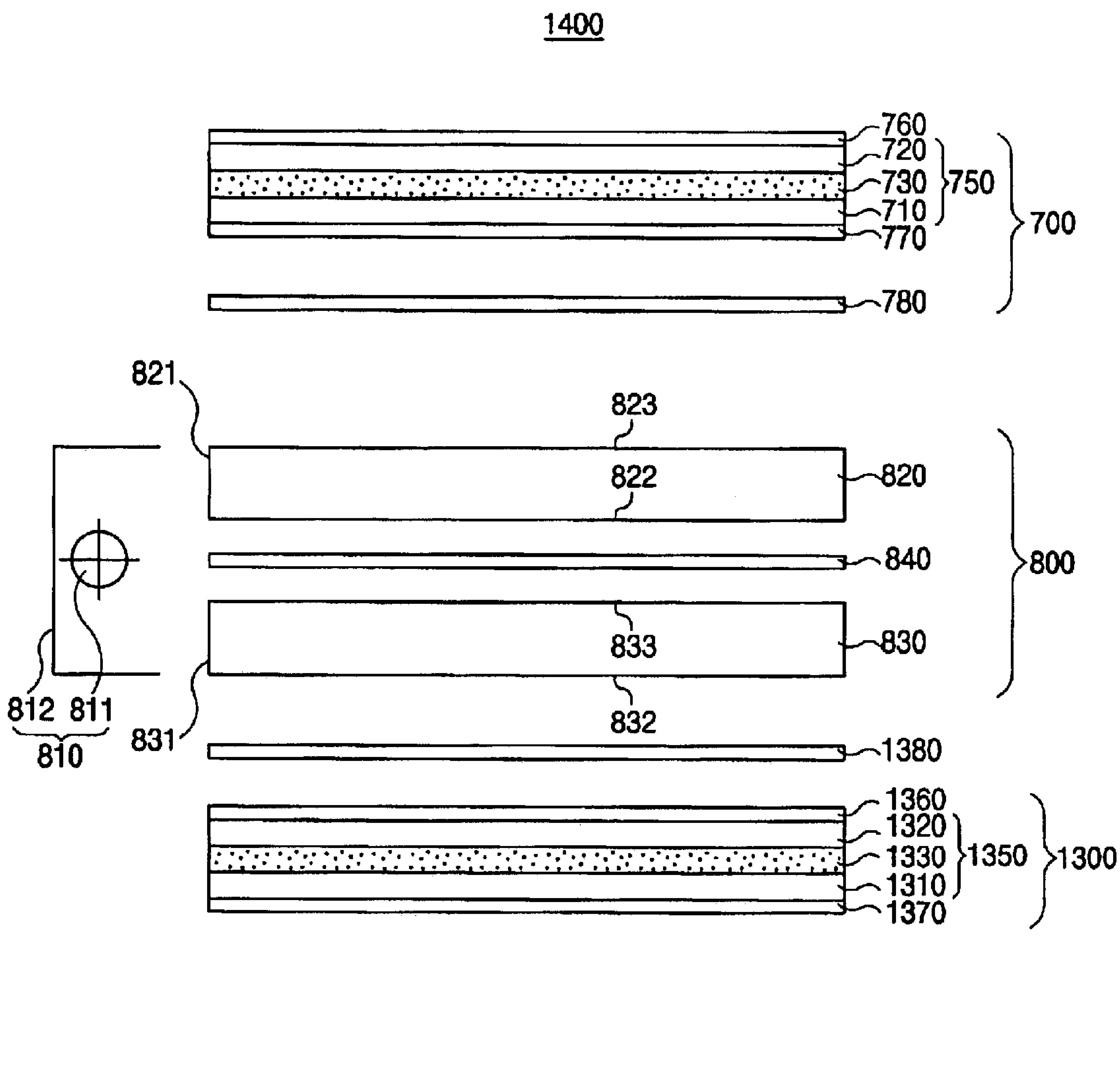
FIG.16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LIQUID CRYSTAL DISPLAY DEVICE INCLUDING A TRANSFLECTOR AND A BACKLIGHT BETWEEN TWO LIQUID CRYSTAL DISPLAY PANELS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display (LCD) device, and more particularly to a liquid crystal display device in which a light loss of the liquid crystal display device is reduced in a transmission mode and a bi-directional display is provided.

2. Description of the Related Art

In these days, electronic display devices become more important for communicating and processing various information. Also, various types of electronic display devices are widely used in different industrial fields.

Generally, an electronic display device visually provides a variety of information to a user. In other words, an electrical information signal output from electronic devices is converted into a visible optical information signal in an electronic display device. Such an electronic display device serves as an interfacing means between a user and the electronic devices.

Meanwhile, owing to developments in the semiconductor technology, recent electronic devices are generally driven by lower voltage and lower power, and have a slimmer size and a lighter weight. With such a trend, a flat panel type display device which is slimmer and lighter and requires lower driving voltage and power becomes in more demand and desirable.

An LCD device among the various types of flat panel display devices is much slimmer and lighter than any other display devices, and has a lower driving voltage and lower power consumption, and also has the displaying quality similar to that of CRT-type display devices. Therefore, LCD devices are widely used in various electronic equipments.

Recently, an LCD device for performing a bi-directional image display has been developed.

Specifically, a conventional LCD device for performing the bi-directional image display includes a backlight, a first LCD panel and a second LCD panel. The first LCD panel is disposed above (or below) the backlight, and the second LCD panel is disposed below (or above) the backlight.

In the conventional LCD device for performing the bi-directional image display, light radiated from a lamp(s) is divided into two groups of light. A first group of light is provided to the first LCD panel, and a second group of light is provided to the second LCD panel. The conventional LCD device only has the function of dividing the light radiated from the lamp(s), but does not have the function of regulating an amount of each of the two groups. It is thus desired that an LCD device can divide the light radiated from the lamp(s) into two groups and also can regulate the amount of each of the two groups.

An LCD panel, which is available for the LCD device capable of performing the bi-directional image display, may have a structure in which the LCD panel can display images in a transmission mode or a reflection mode according to an amount of external light. The LCD panel includes a first substrate, a second substrate, a liquid crystal layer interposed between the first and second substrates, and pixel electrodes. The pixel electrodes are formed on the first substrate, and each of the pixel electrodes has a transparent electrode region and a reflective electrode region. Light is transmitted through the transparent electrode region in the transmission mode, and is reflected by the reflective electrode region in the reflection mode. Accordingly, the LCD panel displays images by means of the transparent electrode region in the transmission mode, and displays images by means of the reflective electrode region in the reflection mode.

The conventional LCD device having the above structure has at least the following problems.

First, since a display area of the LCD device is divided into a transmission area used in the transmission mode and a reflection area used in the reflection mode, it is not effective in aspect of utilization of the display area.

Second, since the conventional LCD device has to employ the wide band ¼ wavelength phase difference plates covering an overall frequency band of the visible ray, as well as a first and a second polarizing plates attached on each of the first and second substrates, a manufacturing cost is elevated compared with a transmission type LCD device that displays images by means of a backlight disposed under the LCD panel.

Third, since the polarization characteristic in the transmission mode causes a light loss of 50%, there are drawbacks in that a light transmissivity decreases by 50% and a contrast ratio (C/R) is lowered.

Fourth, since Δnd (Δn: a value for representing optical anisotropy or refractive anisotropy; d: cell gap) of a liquid crystal layer is only 0.24 μm which is a half of Δnd (0.48 μm) of the conventional transmission type LCD device, the cell gap of the liquid crystal cell should be decreased to a level of 3 μm, and the Δn of the liquid crystal also should be decreased. Accordingly, there are problems in that the manufacturing process becomes difficult and degeneration in the reliability of the liquid crystal is caused.

SUMMARY OF THE INVENTION

Accordingly, the present invention is to solve the aforementioned and other problems of the conventional art, and it is an object of the present invention to provide an LCD device capable of simplifying a structure of an LCD panel, decreasing light loss in the transmission mode and performing a bi-directional image display.

In one aspect, there is provided a liquid crystal display device comprising: a first display unit including a first liquid crystal display panel having a first substrate, a second substrate and a first liquid crystal layer between the first and second substrates, and a transflective film disposed under the first liquid crystal display panel, the transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternately stacked, so that the transflective film partially reflects and partially transmits incident light incident onto the transflective film; a second display unit including a second liquid crystal display panel having a third substrate, a fourth substrate and a second liquid crystal layer between the third and fourth substrates; and a light supplying unit disposed between the first and second display units, the light supplying unit generating a first light to provide the first display unit with a first part of the first light and the second display unit with a second part of the first light, and the light supplying unit controlling an amount of the first and second parts of the first light to regulate a contrast ratio of a luminance between the first and second display units.

According to another aspect of the invention, there is provided a liquid crystal display device comprising: a first display unit including a first liquid crystal display panel having a first substrate, a second substrate and a first liquid crystal layer disposed between the first and second substrates, and a first transflective film disposed under the first liquid crystal display panel, the first transflective film having a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternately stacked, so that the first transflective film partially reflects and partially transmits a first incident light incident onto the first transflective film; a second display unit including a second liquid crystal display panel having a third substrate, a fourth substrate and a second liquid crystal layer disposed between the third and fourth substrates; and a light supplying unit disposed between the first and second display units, the light supplying unit dividing a first light, which is a first part of a light generated from an light source, into a third light and a fourth light to provide the first and second display units with the third and fourth light, respectively, and dividing a second light, which is a second part of the light generated from the light source, into a fifth light and a sixth light to provide the first and second display units with the fifth and sixth light, respectively, the light supplying unit controlling an amount of the third, fourth, fifth and sixth light to regulate a contrast ratio of a luminance between the first and second display units.

In an exemplary embodiment, the LCD device includes a first transflective film disposed at one of the first and second display units. The first transflective film has a plurality of layers in which a first layer and a second layer having different refractivity indexes from each other are alternately stacked, so that the first transflective film partially reflects and partially transmits a first incident light incident on the first transflective film. The LCD device includes a light supplying unit disposed between the first and second display units. The light supplying unit controls an amount of the light that is provided to the first and second display units, to thereby regulate a contrast ratio of a luminance between the first and second display units. Therefore, the structure of an LCD panel for performing a bi-directional image display can be simplified, and the light loss in the transmission mode can be reduced.

In another exemplary embodiment, the LCD device includes an anisotropy transflective film or an isotropy transflective film disposed at one of the first and second display units. The anisotropy transflective film has an optical characteristic in which light components in a specific direction are strongly reflected and polarization components in a direction perpendicular to the specific direction are partially transmitted and reflected depending on polarized state and direction of the incident light incident thereto. The isotropy transflective film has an optical characteristic in which light components are partially transmitted and reflected independent of polarized state and direction of the incident light. As a result, by a light restoring process occurring between the transflective film and the backlight, the restored light is transmitted through the transflective film repeatedly, so that transmissivity and light efficiency can be enhanced.

Further, the LCD device has no reflection electrode within liquid crystal (LC) cell and has no ¼-wavelength phase difference plate on each of the first substrate and the second substrate. Accordingly, compared with a conventional LCD device, the LCD device of the present invention can be made in more simple structure, and degeneration in the reliability of the liquid crystal can be prevented.

Furthermore, since the light supplying unit disposed between the first and second display units regulates the luminance of the light generated from the lamp to provide the first and second display units with the light of which luminance is regulated, the LCD device of the present invention satisfies the demand from users.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

FIG. **1** is a sectional view showing a liquid crystal display device according to an exemplary embodiment of the present invention;

FIG. **2** is a sectional view showing a first display unit of FIG. **1**;

FIG. **3** is a schematic view showing a structure of a transflective film of FIG. **1**;

FIGS. **4**A to **4**C are sectional views for illustrating a position of a light scattering layer that is available for the liquid crystal display device of FIG. **1**;

FIGS. **5**A and **5**B are schematic views for illustrating an operation mechanism of the liquid crystal display device of FIG. **1** for which an integrally formed transflective film is available in the reflection mode;

FIGS. **6**A and **6**B are schematic views for illustrating an operation mechanism of the liquid crystal display device of FIG. **1** for which an integrally formed transflective film is available in the transmission mode;

FIGS. **7**A and **7**B are schematic views for illustrating an operation mechanism of the liquid crystal display device of FIG. **1** for which a separation type transflective film is available in the reflection mode;

FIGS. **8**A and **8**B are schematic views for illustrating an operation mechanism of the liquid crystal display device of FIG. **1** for which a separation type transflective film is available in the transmission mode;

FIG. **9** is a schematic view showing a structure of a liquid crystal display device of FIG. **1** further including a light reflection pattern and optical sheets;

FIG. **10** is a plane view showing the light reflection pattern formed on a light guiding member of FIG. **9**;

FIG. **11** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention;

FIG. **12** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention;

FIG. **13** is a view showing a first display unit of FIG. **12**;

FIG. **14** is a schematic view showing a structure of the liquid crystal display device of FIG. **12** further including light reflection patterns and optical sheets;

FIG. **15** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention; and

FIG. **16** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Now, exemplary embodiments of the present invention will be described in detail with reference to the annexed drawings.

FIG. **1** is a sectional view showing a liquid crystal display device according to an exemplary embodiment of the present invention, and FIG. **2** is a sectional view showing a first display unit of FIG. **1**.

Referring to FIG. **1**, an LCD device includes a first display unit **100** for displaying first images, a second display unit **200** for displaying second images, and a light supplying unit (Hereinafter, refer to a backlight) **300** disposed between the first and the second display units **100**, **200**.

The first display unit **100** includes a first LCD panel **150**, a first polarizing plate **160**, a second polarizing plate **170** and a transflective film **180**. The first LCD panel **150** includes a first substrate **110**, a second substrate **120** of which an lower surface is arranged facing the first substrate **110**, and a first liquid crystal layer **130** disposed between the first substrate **110** and the second substrate **120**.

As shown in FIG. **2**, on a first insulating substrate **111** is formed a first transparent electrode **112** made of, for example, conductive oxide film such as indium tin oxide (ITO), to thereby constitute the first substrate **110**. On a second insulating substrate **121** is formed a second transparent electrode **122** made of, for example, conductive oxide film such as ITO, to thereby constitute the second substrate **120**. The first transparent electrode **112** of the first substrate **110** is arranged facing the second transparent electrode **122** of the second substrate **120**.

The first liquid crystal layer **130** is made of, for example, 90° twisted TN (Twisted Nematic) liquid crystal composition. According to the present embodiment, the first liquid crystal layer **130** has "Δnd" of about 0.2–0.6 μm, that is a product of a refractive anisotropy (Δn) and a thickness (d) of the first liquid crystal layer **130**, preferably about 0.48 μm. In the LCD device of the present embodiment, the liquid crystal optical conditions of a conventional transmission-type LCD device may be adopted without a variation, thereby preventing the reliability of the liquid crystal from being affected.

On an upper surface of the first LCD panel **150** is disposed a first polarizing plate **160**, and a second polarizing plate **170** is formed on a lower surface of the first LCD panel **150**. The first and second polarizing plates **160** and **170** absorb a predetermined polarization component and transmit other polarization components, thereby allowing incident light to be transmitted in a specific direction. The first and second polarizing plates **160** and **170** are linear polarizers of which polarizing axes are arranged to be perpendicular to each other.

Under the second polarizing plate **170** is disposed a transflective film **180** including at least two transparent layers having different refractivity index values from each other, i.e., a first layer **181** and a second layer **182** alternately stacked as shown in FIG. **3**. The transflective film **180** partially reflects and partially transmits the incident light incident thereto. Accordingly, the LCD device in accordance with the present embodiment has a reflection light path (R) and a transmission light path (T). In the reflection light path (R), the incident light is incident toward the second substrate **120**, transmits through the first substrate **110**, is reflected by the transflective film **180**, and exits through the second substrate **120**. In the transmission light path (T), the incident light is incident from the backlight **300** onto the first substrate **110**, is transmitted through the transflective film **180**, and exits through the second substrate **120**.

Referring again to FIG. **1**, the second display unit **200** includes a second LCD panel **250**, a third polarizing plate **260**, a fourth polarizing plate **270**. The second LCD panel **250** includes a third substrate **210**, a fourth substrate **220** of which an lower surface is arranged facing the third substrate **210**, and a second liquid crystal layer **230** disposed between the third substrate **210** and the fourth substrate **220**.

On an upper surface of the second LCD panel **250** is disposed a third polarizing plate **260**, and a fourth polarizing plate **270** is formed on a lower surface of the second LCD panel **250**. The third and fourth polarizing plates **260** and **270** absorb a predetermined polarization component and transmit other polarization components, thereby allowing incident light to be transmitted in a specific direction. The third and fourth polarizing plates **260** and **270** are linear polarizers of which polarizing axes are arranged to be perpendicular to each other.

The backlight **300** is installed between the first and the second display units **100**, **200**. The backlight **300** generates light and provides the first and second display units **100**, **200** with a part of the generated light.

As shown in FIG. **1**, the backlight **300** includes a light guiding member **320** and a luminance controlling member **330**. The light guiding member **320** guides the light generated form a lump unit **310**, and the luminance controlling member **330** controls the luminance of the light that is supplied to the first and second display units **100**, **200**.

The light guiding member **320** has a shape of a rectangular parallelepiped plate, and includes four side faces including an incident face **321**, a light reflective-transmissive face **322** and a light exiting face **323**. The light exiting face **323** faces the light reflective-transmissive face **322**.

The light incident face **321** receives first light L**1** generated from the lamp unit **310**. The lamp unit **310** includes a lamp **311**, a lamp reflector **312** covering the lamp **311** to reflect the first light L**1**. The lamp **311**, preferably, employs a linear light source such as a cold cathode fluorescent lamp (CCFL), but is not limited to the linear light source. The lamp **311** may be a point light source such as a light emitting diode (LED).

The first light L**1** generated from the lamp **311** is incident into the light guiding member **320** through the light incident face **321**. The light guiding member **320** divides the first light L**1** to exit second and third lights L**2**, L**3**. The light guiding member **320** exits the second light L**2** or a part of the first light L**1** toward the first display unit **100**, and exits the third light L**3** or the other part of the first light L**1** toward the second display unit **200**. Specifically, the second light L**2** includes the light exiting directly from the light exiting face **323** and the light being reflected by the light reflective-transmissive face **322**. The third light L**3** is the light that passes through the light reflective-transmissive face **322** to proceed toward the second display unit **200**.

The light guiding member **320** is able to provide both the first and second display units **100**, **200** with light. However, it is difficult for the light guiding member **320** to control the luminance of the light supplied to the first and second display units **100**, **200**. Accordingly, the backlight **300** further includes a luminance controlling member **330** to as to regulate the luminance between the first display unit **100** and the second display unit **200**.

The luminance controlling member **330** reflects a part of the third light L**3** to provide the first display unit **100** with the reflected part of the third light L**3** through the light guiding member **320**, and transmits the other part of the third light L**3** to provide the second display unit **200** with the other part of the third light L**3**.

The luminance controlling member **330** may have a sheet shape or a plate shape thicker than the sheet shape, and is made of, for example, polyethylene terephthalate (PET) treated by foaming agent. The luminance controlling member **330** reflects about 80% of the third light L**3** and transmits about 20% of the third light L**3** according to one embodiment of the present invention. In addition, the luminance controlling member **330** reflects about 20% of the third light L**3** and transmits about 80% of the third light L**3** according to another embodiment of the present invention.

The material of the luminance controlling member **330** is not limited to polyethylene terephthalate (PET) treated by foaming agent. The luminance controlling member **330** may be made of any material that can partially reflect and partially transmit light.

FIG. **3** is a schematic view showing a structure of the transflective film of FIG. **1**.

Referring to FIG. **3**, when it is assumed that the transflective film **180** has a film thickness in direction z and a film plane in x-y plane, the transflective film **180** according to one aspect of the invention is characterized such that the first layer **181** thereof has a refractive anisotropy in its film plane, i.e., x-y plane, and the second layer **182** does not have a refractive anisotropy in its film plane. The film plane is parallel to a surface of the transflective film.

The transflective film **180** has various transmissivity and reflectivity characteristics depending on a polarized state and a direction of the incident light. For instance, when it is assumed that a direction parallel to an elongated direction of the transflective film **180** is x-direction and a direction perpendicular to the elongated direction is y-direction, the first layer **181** having a high refractivity and refractive anisotropy within the film plane and the second layer **182** not having refractive anisotropy each have three main refractive indexes, n_x, n_y and n_z, that satisfy the following relationships (1):

$$n1_x=n1_z\neq n1_y;$$

$$n2_x=n2_y=n2_z;$$

$$n1_x\neq n2_x;$$

$$n1_y\neq n2_y; \text{ and}$$

$$|n1_x-n2_x|<|n1_y-n2_y| \quad (1).$$

(n**1**x, n**1**y, n**1**z denote main refractive indexes of the first layer in the x-axis, y-axis, z-axis, respectively, and n**2**x, n**2**y, n**2**z denote main refractive indexes of the second layer in an x-axis, y-axis, z-axis, respectively)

Thus, if a refractivity difference in the x-direction between the first layer **181** and the second layer **182** is less than a refractivity difference in the y-direction between the first layer **181** and the second layer **182**, when a non-polarized light is incident in the direction perpendicular to the film plane, i.e., z-direction, a polarization component polarized parallel to the y-direction is mostly reflected due to a high difference in the refractivity based on Fresnel's equation, but a polarization component polarized parallel to the x-direction partially is transmitted and reflected due to a low difference in the refractivity.

There are disclosed methods for enhancing the display brightness by using a reflection type polarizing plate made of dielectric multilayered film having birefringence in Japanese Patent Laid Open Publication No. 9-43596 and International Patent Publication No. WO 97/01788. The dielectric multilayered film having birefringence has a structure in which two kinds of polymer layers are alternately stacked. One of the two kinds of polymer layers is selected from a polymer group having a high refractivity and the other is selected from a polymer group having a low refractivity.

Hereinafter, the structure of the dielectric multilayered film is reviewed in an aspect of optical property.

For instance, when it is assumed that there is the following relationship between a first layer in which a material having a high refractivity is elongated, and a second layer in which a material having a low refractivity is elongated:

$$n1_x=n1_z=1.57,\ n1_y=1.86; \text{ and}$$

$$n2_x=n2_y=n2_z=1.57.$$

Thus, in case that refractivity values of the first and second layers in the x-direction and the z-direction are identical to each other and refractivity values of the first and second layers in the y-direction are different from each other, when a non-polarized light is incident in the direction perpendicular to the film plane, i.e., z-direction, polarization components in the x-direction are all transmitted, polarization components in the y-direction are all reflected based on Fresnel's equation. A representative example of birefringence dielectric multilayered films-having the above characteristics is DBEF (Dual brightness enhancement film) made by 3M company. The DBEF has a multilayered structure in which two kinds of films made of different material are alternately stacked to form a few hundred layers. In other words, polyethylene naphtalate layer having a high birefringence and polymethyl methacrylate (PMMA) layer are alternately stacked to form the DBEF layer. Since naphthalene radical has a flat plane structure, when these radicals are adjacently placed to each other, it is easy to stack the polyethylene naphtalate layer and the DBEF layer, so that the refractivity in the stacking direction becomes considerably different from those in other directions. On the contrary, since the PMMA is an amorphous polymer and is isotropically aligned, the PMMA has an identical refractivity in all directions.

The DBEF made by 3M company transmits all x-directional polarization components and reflects all y-directional polarization components, while the transflective film **180** according to one aspect of the invention mostly reflects a specific-directional (for instance, y-directional) polarization component, but partially reflects and transmits polarization component, which is polarized in a direction (for instance, x-direction) perpendicular to the specific direction. The transflective film **180** may be made by vertically attaching two anisotropic transflective films each having transmissivity and reflectivity varying depending on polarized state and direction of light incident on the transflective film **180**. Also, the transflective film **180** may be made by attaching an anisotropic transflective film having various transmissivity and reflectivity depending on polarized state and direction of the incident light and a transflective film having isotropic reflection and transmission characteristics independent of polarized state and direction of incident light. The two transflective films can be made in an integrally formed structure, or made in a separately formed film structure.

Also, according to another aspect of the invention, the transflective film **180** has isotropic reflection and transmission characteristics independent of a polarized state and a direction of the incident light. For instance, if it is assumed that a direction parallel to an elongated direction of the film is x-direction and a direction perpendicular to the elongated direction of the film is y-direction, the first layer **181** having a high refractivity and the second layer **182** having a low refractivity both have a refractive isotropy in x-y plane of the film, and the first and second layers **181** and **182** each have three main refractive indexes, n_x, n_y and n_z, that satisfy the following relationships:

$$n1_x = n1_y = n1_z; \text{ and}$$

$$n2_x = n2_y = n2_z \neq n1_z \quad (2).$$

Thus, in case that the first and second layers **181** and **182** have different refractivity index values in the z-direction, when non-polarized light is incident in the direction (i.e., z-direction) perpendicular to the film, polarization components in the x-direction are partially transmitted and reflected, and polarization components in the y-direction are partially transmitted and reflected according to Fresnels's equation. At this time, the reflectivity of the reflected light can be adjusted to match with characteristics of the LCD device by controlling the thickness or the refractivity of the first layer **181** or the second layer **182**. In other words, a reflection-characteristic-enhanced LCD device, enhances the reflectivity, whereas an LCD device, in which transmission characteristic is considered to be an important factor, lowers the reflectivity to thereby enhance the transmissvity.

As described above, the transflective film **180** of the invention can be formed to have an anisotropy characteristic in which transmissivity and reflectivity of the film **180** varies with a polarized state and a direction of the incident light, or can be formed to have an isotropy characteristic in which transmissivity and reflectivity of the film **180** do not depend on a polarized state and a direction of the incident light. In any case, it is desirable that the transflective film **180** has a reflectivity of more than or equal to about 4% with respect to polarization component in all directions when light is incident in a direction perpendicular to the film plane.

The transflective film **180** of the invention can be made in an integrally formed structure together with the second polarizing plate **170**, or made in a separately formed sheet structure separated from the second polarizing plate **170**. In case that the transflective film **180** is made in an integrally formed structure together with the second polarizing plate **170**, it is possible to decrease the thickness of a liquid crystal (LC) cell, and the LCD device has an advantage in an aspect of manufacturing cost.

In the above, there is explained a method of forming the transflective film **180** by depositing or coating the polymer multilayered film on a surface of the second polarizing plate **170**, which may be contrasted with the anti-reflection treatment in a polarizing plate. In other words, in the anti-reflection treatment, two kinds of transparent films having different refractivity are repeatedly deposited or coated in a constant thickness such that destructive interference occurs by multi-reflection within the polymer multilayered film. However, in order to form a transflective film capable of partially transmitting and partially reflecting an incident light, the film thickness should be adjusted such that constructive interference occurs.

FIGS. **4**A and **4**B are sectional views for illustrating a position of a light scattering layer that is available for the liquid crystal display device of FIG. **1**.

As shown in FIGS. **4**A and **4**B, the LCD device in accordance with the current embodiment may further include a light scattering layer **175** formed on the first substrate **110** or the second substrate **120** in order to prevent specular reflection and to properly diffuse the reflected light in various angles.

For instance, as shown in FIGS. **4**A and **4**B, it is possible to form the light scattering layer **175** between the first substrate **110** and the second polarizing plate **170**, or between the second substrate **120** and the first polarizing plate **160**. It is also possible to form the light scattering layer **175** between the second polarizing plate **170** and the transflective film **180**. The light scattering layer **175** may be made in an integrally formed structure together with the second polarizing plate **170** or the first polarizing plate **160**, or made in a separate sheet structure separated from the polarizing plates **160**, **170**. Further, the light scattering layer **175** can be made in the form of a plastic film in which transparent beads are dispersed. Moreover, the light scattering layer **175** can be made in a state in which beads are added to adhesive, which makes it possible to directly attach the first substrate **110** to the second polarizing plate **170**.

Furthermore, in order to optimize light efficiency in the LCD device in accordance with the current embodiment of the invention, it is possible to form a phase difference plate (not shown) on the first substrate **110** or the second substrate **120**. For instance, the phase difference plate is formed in an integrally formed structure together with polarizing plates **160**, **170** or a separate film structure separated from the polarizing plates **160**, **170** between the first substrate **110** and the second polarizing plate **170**, or between the second substrate **120** and the first polarizing plate **160**.

Hereinafter, there is described in detail an operation mechanism of the LCD device having the above structure.

FIG. **5**A through FIG. **6**B are schematic views for illustrating operation mechanisms of reflection mode and transmission mode in the LCD device in which the transflective film **180** is made an integrally formed structure together with the second polarizing plate **170**. Here, polarization directions of the light are represented on the basis of a polarizing axis of the first polarizing plate **160**, and partially reflected light and partially transmitted light are represented by a dotted line.

First, when a pixel voltage is not applied (OFF) in the reflection mode, as shown in FIG. **5**A, light that is incident from an external source is transmitted through the first polarizing plate **160**, so that the light is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. The linearly polarized light is transmitted through the liquid crystal layer **130** and the first transparent electrode **112**, so that the linearly polarized light is linearly polarized in a direction perpendicular to the polarizing axis of the first polarizing plate **160** and is then incident into the transflective film **180** made in an integrally formed structure together with the second polarizing plate **170**. At this time, since the polarizing axis of the second polarizing plate **170** is perpendicular to that of the first polarizing plate **160**, the light that is incident into the second polarizing plate **170** comes to have the direction parallel to the polarizing axis of the second polarizing plate **170**. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the second polarizing plate **170** is partially transmitted through the transflective film **180** and is partially reflected by the transflective film **180**. In other words, in case that the transflective film **180** has the refractivity characteristic of the relationship (1), a polarization component, which is polarized in the x-direction parallel to the elongated direction of the transflective film **180**, of the light incident into the transflective film **180** is partially transmitted and reflected, whereas a polarization component which is polarized in the direction perpendicular to the elongated direction is mostly reflected. Further, in case that the transflective film **180** has the refractive characteristic of the relationship (2), of the light incident into the transflective film **180**, the polarization components which are polarized in the x- and y-directions are partially transmitted and partially reflected.

Thus, the linearly polarized light reflected by the transflective film **180** is transmitted through the first transparent electrode **112** and the liquid crystal layer **130**, so that it is linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate **160**. Afterwards, the light is transmitted through the first polarizing plate **160**, so that a white image is displayed. Also, the light transmitted through the transflective film **180** is restored between the transflective film **180** and the backlight **300**, and the restored light is repeatedly subject to the procedure of partial reflection and partial transmission. As a consequence, light loss is eliminated and reflectivity and light efficiency are enhanced.

When a maximum pixel voltage is applied (ON) in the reflection mode, as shown in FIG. **5**B, light incident from an external source is transmitted through the first polarizing plate **160**, so that the light is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. Afterwards, the linearly polarized light is transmitted through the liquid crystal layer **130** without a variation in the polarized state, and is then incident into the transflective film **180** integrally formed with the second polarizing plate **170**. At this time, since the linearly polarized light is perpendicular to the polarizing axis of the second polarizing plate **170**, the light is all absorbed in the second polarizing plate **170**. Thus, the linearly polarized light is not reflected by the transflective film **180**, so that a black image is displayed.

When a pixel voltage is not applied (OFF) in the transmission mode, as shown in FIG. **6**A, light irradiated from the backlight **300** is incident into the transflective film **180** integrally formed with the second polarizing plate **170**. In case that the transflective film **180** has the refractive characteristic of the relationship (1), a polarization component, which is polarized parallel to the x-direction, of the light parallel to the polarizing axis of the second polarizing plate **170** is partially transmitted and reflected, whereas a polarization component which is polarized parallel to the y-direction is mostly reflected. Also, in case that the transflective film **180** has the refractive characteristic of the relationship (2), the light, which is parallel to the polarizing axis of the second polarizing plate **170**, is partially transmitted and partially reflected because all polarization components which are polarized in the x-direction and y-direction are partially transmitted and reflected.

Thus, the light that has been transmitted through the transflective film **180** and the second polarizing plate **170** becomes a linearly polarized light having a vibrating direction parallel to the polarizing axis of the second polarizing plate **170**. The linearly polarized light is transmitted through the first transparent electrode **112** and the liquid crystal **130**, so that it is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate **160** is transmitted through the first polarizing plate **160**, so that a white image is displayed. Also, light reflected by the transflective film **180** is restored between the backlight **300** and the transflective film **180**, and then is repeatedly subject to the above steps. Thus, polarization components parallel to the x-direction or polarization components parallel to the x- and y-directions are successively transmitted through the transflective film **180** to be used, so that light loss is reduced and transmissivity and light efficiency are enhanced.

When a maximum pixel voltage is applied (ON) in the transmission mode, as shown in FIG. **6**B, light irradiated from the backlight **300** is incident into the transflective film **180** integrally formed with the second polarizing plate **170**, so that the light parallel to the polarizing axis of the second polarizing plate **170** is partially transmitted and reflected. The light that has been transmitted through the transflective film **180** and the second polarizing plate **170** is converted into light lineally polarized in the direction parallel to the polarizing axis of the second polarizing plate **170**, i.e., in the direction perpendicular to the polarizing axis of the first polarizing plate **160**. The linearly polarized light is transmitted through the first transparent electrode **112** and the liquid crystal layer **130** without a variation in the polarized state. Accordingly, the light linearly polarized in the direction perpendicular to the polarizing axis of the first polarizing plate **160** is not transmitted through the first polarizing plate **160**, so that a black image is displayed.

FIG. **7**A through FIG. **8**B are schematic views for illustrating an operation mechanism in the transmission mode and the reflection mode of an LCD device in which the transflective film **180** is separated from the second polarizing plate **170** and is made in a sheet structure. Here, polarization directions of the light are represented on the basis of a polarizing axis of the first polarizing plate **160**, and partially reflected light and partially transmitted light by a dotted line.

First, when a pixel voltage is not applied (OFF) in the reflection mode, as shown in FIG. **7**A, light incident from an external source is transmitted through the first polarizing plate **160**, so that the light is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. The linearly polarized light is transmitted through the liquid crystal layer **130** and the first transparent electrode **112**, so that the linearly polarized light is linearly polarized in a direction perpendicular to the polarizing axis of the first polarizing plate **160** and is then incident into the second polarizing plate **170**. At this time, since the polarizing axis of the second polarizing plate **170** is perpendicular to that of the first polarizing plate **160**, the light that has been linearly polarized in a direction perpendicular to the polarizing axis of the first polarizing plate **160** is transmitted through the second polarizing plate **170** and is then incident into the transflective film **180**. In case that the transflective film **180** has the refractivity characteristic of the relationship (1), a polarization component, which is polarized in the x-direction parallel to the elongated direction of the transflective film **180**, of the light incident into the transflective film **180** is partially transmitted and reflected, whereas a polarization component, which is polarized in the y-direction perpendicular to the elongated direction, is mostly reflected. Further, in case that the transflective film **180** has the refractive characteristic of the relationship (2), of the light incident into the transflective film **180**, the polarization components polarized in the x- and y-directions are partially transmitted and partially reflected.

Thus, since the linearly polarized light reflected by the transflective film **180** is parallel to the polarizing axis of the second polarizing plate **170**, it is transmitted through the second polarizing plate **170**, and is incident into the liquid crystal layer **130** via the first transparent electrode **112**. The linearly polarized light is transmitted through the liquid crystal layer **130**, whereby it is linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate **160**. Afterwards, the light is transmitted through the first polarizing plate **160**, so that a white image is displayed. Also, the lights that have been transmitted through the transflective film **180** are restored between the transflective film **180** and the backlight **300**, and the restored light is repeatedly subject to the procedure of a partial reflection and a partial transmission. As a consequence, light loss is reduced and reflectivity and light efficiency are enhanced.

When a maximum pixel voltage is applied (ON) in the reflection mode as shown in FIG. **7**B, light incident from an external source is transmitted through the first polarizing plate **160**, so that the light is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. Afterwards, the linearly polarized light is transmitted through the liquid crystal layer **130** without a variation in the polarized state, and is then incident into the second polarizing plate **170**. At this time, since the linearly polarized light is perpendicular to the polarizing axis of the second polarizing plate **170**, the light is all absorbed in the second polarizing plate **170**. Thus, since the linearly polarized light is not reflected by the transflective film **180**, a black image is displayed.

When a pixel voltage is not applied (OFF) in the transmission mode, as shown in FIG. **8**A, light irradiated from the backlight **300** is incident into the transflective film **180**, so that the light is partially transmitted and reflected. In case that the transflective film **180** has the refractive characteristic of the relationship (1), polarization component, which is polarized in the x-direction parallel to the elongated direction of the transflective film **180**, of the light that have been incident into the transflective film **180** is partially transmitted and reflected, whereas polarization components, which are polarized in the y-direction perpendicular to the elongated direction, are mostly reflected. Also, in case that the transflective film **180** has the refractive characteristic of the relationship (2), polarization components, which is polarized in the x- and y-directions, of the light incident into the transflective film **180** is partially transmitted and reflected.

Thus, the light that has been transmitted through the transflective film **180** and the second polarizing plate **170** is linearly polarized in a direction parallel to the polarizing axis of the second polarizing plate **170**. Afterwards, the linearly polarized light is transmitted through the first transparent electrode **112** and the liquid crystal **130**, so that it is linearly polarized in a direction parallel to the polarizing axis of the first polarizing plate **160**. Accordingly, the light linearly polarized in the direction parallel to the polarizing axis of the first polarizing plate **160** is transmitted through the first polarizing plate **160**, so that a white image is displayed. Also, light reflected by the transflective film **180** is restored between the backlight **300** and the transflective film **180**, and then is repeatedly subject to the above steps. Thus, polarization components polarized parallel to the x-direction or polarization components polarized parallel to the x- and y-directions successively are transmitted through the transflective film **180** and are used, so that light loss is reduced and transmissivity and light efficiency are enhanced.

When a maximum pixel voltage is applied (ON) in the transmission mode, as shown in FIG. **8**B, light irradiated from the backlight **300** is incident into the transflective film **180**, so that the incident light is partially transmitted through the transflective film **180** and is partially reflected by the transflective film **180**. The light that has been transmitted through the transflective film **180** is transmitted through the second polarizing plate **170**, so that it is converted into light lineally polarized parallel to the polarizing axis of the second polarizing plate **170**, i.e., a direction perpendicular to the polarizing axis of the first polarizing plate **160**. Afterwards, the linearly polarized light is transmitted through the first transparent electrode **112** and the liquid crystal layer **130** without a variation in the polarized state. Accordingly, the light linearly polarized in the direction perpendicular to the polarizing axis of the first polarizing plate **160** cannot be transmitted through the first polarizing plate **160**, so that a black image is displayed.

FIG. **9** is a schematic view showing a structure of a liquid crystal display device further including a light reflection pattern and optical sheets, and FIG. **10** is a plane view showing the light reflection pattern formed on a light guiding member of FIG. **9**.

Referring to FIG. **9**, a light reflection pattern **322***a* is formed on the reflective-transmissive face **322** of the light guiding member **320** so as to face the luminance controlling member **330**. The light reflection pattern **322***a* partially reflects the light that is incident onto the light reflective-transmissive face **322**, and changes the light path of the light incident onto the light reflective-transmissive face **322** so that a part of the light incident onto the light reflective-transmissive face **322** may proceed toward a light exiting face **323**.

The light reflection pattern **322***a* is formed on the light reflective-transmissive face **322**. For example, the light reflection pattern **322***a* includes a plurality of dots arranged in a matrix shape on the light reflective-transmissive face **322**. Paste mixed with material having a high light reflectivity is printed on the light reflective-transmissive face **322** by a silk screen printing method, so that light reflection pattern **322***a* is formed on the light reflective-transmissive face **322**.

The light reflection pattern **322***a* formed on the light reflective-transmissive face **322** may have various patterns with certain regularity. For example, the dots of the light reflection pattern **322***a* are arranged in a matrix shape on the light reflective-transmissive face **322**, and the size of the respective dots increases in proportion to the distance between each dot and the light incident face **321**. In other words, the dots of the light reflection pattern **322***a* have different sizes such that a dot has a smaller size as it is closer to the light incident face **321**. The size of a dot of the light reflection pattern **322***a* is determined according to the distance between the dot and the light incident face **321**, so that the light reflectivity by the light reflection pattern **322***a* is maintained substantially uniform over the entire surface of the light reflective-transmissive face **322**.

Referring again to FIG. **9**, in the light guiding member **320** of this embodiment, a vertical distance between the light reflective-transmissive face **322** and the light exiting face **323** is substantially uniform. In other words, the light reflective-transmissive face **322** is substantially parallel with the light exiting face **323**.

In another embodiment, however, the light reflective-transmissive face **322** may not be parallel with the light exiting face **323**. Specifically, the vertical distance between the light reflective-transmissive face **322** and the light exiting face **323** decreases in proportion to the distance between a point on the light exiting face **323** (or the light reflective-transmissive face **322**) and the light incident face **321**. Preferably, the vertical distance between the light reflective-transmissive face **322** and the light exiting face **323** decreases gradually. For example, the light exiting face **323** is parallel with the LCD panel, and the light reflective-transmissive face **322** is tilted by a predetermined angle with respect to the light exiting face **323**.

On the other hand, as shown in FIG. **9**, a first optical sheet **340** is installed on the light exiting face **323** of the light guiding member **320** so as to enhance optical characteristic of the light exiting from the light guiding member **320** by changing optical distribution of the light exiting from the light guiding member **320**. The first optical sheet **340** further includes a first diffusion sheet **342** and a first prism sheet

344. Specifically, the first diffusion sheet **342** disperses the second light L2 and a part of the third light L3 reflected by the luminance controlling member **330**, to thereby provide a uniform luminance distribution. According to one exemplary embodiment of the present invention, at least one first prism sheet **344** is installed on the first diffusion sheet **342**, to thereby enhance a viewing angle of the light exited from the first diffusion sheet **342** by correcting a direction of the light exited from the first diffusion sheet **342**.

In addition, a second optical sheet **350** may be installed between the luminance controlling member **330** and the second LCD panel **200** so as to enhance optical characteristic of the other part of the third light L3 transmitting the luminance controlling member **330** and then proceeding toward the second LCD panel by changing optical distribution of the other part of the third light L3. The second optical sheet **350** may further include a second diffusion sheet **352** and a second prism sheet **354**. Specifically, the second diffusion sheet **352** disperses the other part of the third light L3, to thereby provide a uniform luminance distribution. The second prism sheet **354** corrects a direction of the light exited from the second diffusion sheet **352**, to thereby enhance a viewing angle of the light exited from the second diffusion sheet **352**.

Although the first display unit **100** has the same size as the second display unit **200** in the embodiments in FIGS. **1** to **9**, the first display unit **100** may have a different size from the second display unit **200**.

FIG. **11** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention.

Referring to FIG. **11**, an LCD device **600** includes a first display unit **100**, a second display unit **500** having a different size from the first display unit **100**, and a backlight **300** disposed between the first and second display units **100, 500**.

A first display area of the first display unit **100** is different from a second display area of the second display unit **500**, and in this embodiment, the first display area of the first display unit **100** is larger than the second display area of the second display unit **500**.

When the first display area of the first display unit **100** is larger than the second display area of the second display unit **500**, optical characteristic of the second display unit **500** varies according to a position of the second display unit **500**.

As shown in FIG. **11**, one end of the second display unit **500** is aligned to the light incident face **321** of the light guiding member **320**. When one end of the second display unit **500** is aligned to the light incident face **321** of the light guiding member **320**, a larger amount of light can be collected at the second display unit **500** compared with when one end of the second display unit **500** is located at other positions.

Although not shown in FIG. **11**, one end of the second display unit **500** can be installed apart from the light incident face **321** by a predetermined distance. For example, the second display unit **500** is disposed at the center portion of the light reflective-transmissive face **322** of the light guiding member **320**. In this case, there is a disadvantage that restriction on luminance exists, but there is an advantage that restriction on installation is reduced. In addition, the other end of the second display unit **500** opposite to the one end of the second display unit **500** may be aligned to a side face, opposite to the light incident face **321**, of the light guiding member **320**.

FIG. **12** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention, and FIG. **13** is a view showing a first display unit of FIG. **12**.

Referring to FIG. **12**, an LCD device **900** includes a first display unit **700** for displaying first images, a second display unit **200** for displaying second images, and a backlight **800** disposed between the first and second display units **700, 200**. The first display unit **700** includes a first LCD panel **750**, a first polarizing plate **760**, a second polarizing plate **770** and a transflective film **780**.

Referring to FIG. **13**, the first LCD panel **750** includes a first substrate **710**, a second substrate **720** arranged facing the first substrate **710**, a liquid crystal layer **730** disposed between the first substrate **710** and the second substrate **720**.

Specifically, the first substrate **710** includes a first insulating substrate **711**. On the first insulating substrate **711** is formed a plurality of switching devices, or thin film transistors (TFTs) **712** and a first transparent electrode (or pixel electrode) **714** electrically connected to the TFTs **712**. The TFTs **712** are arranged in a matrix configuration on the first insulating substrate **711**. A gate electrode **712***a* of the TFT **712** is connected a gate line (not shown) extended in a row direction on the first insulating substrate **711**, and a source electrode **712***b* of the TFT **712** is connected a data line (not shown) extended in a column direction on the first insulating substrate **711**. A drain electrode **712***c* of the TFT **712** is electrically connected the first transparent electrode **714** made of a conductive oxidation film such as indium tin oxide (ITO).

An organic insulating layer **713** is formed between the TFT **712** and the first transparent electrode **714**. The organic insulating layer **713** includes a contact hole **713***a* that exposes the drain electrode **712***c*. The organic insulating layer **713** insulates the TFT **712** and the first transparent electrode **714**, and simultaneously allows the first transparent electrode **714** to contact only the drain electrode **712***c*.

The second substrate **720** includes a second insulating substrate **721**. An RGB color filter **722**, a black matrix (BM) layer **723** and a second transparent electrode **724** are formed on the second insulating substrate **721**. On the second insulating substrate **721**, the RGB color filter **722** is arranged in a matrix configuration corresponding to the pixel electrode **714** formed on the first insulating substrate **711**. The black matrix layer **723** is formed between the RGB color filter **722** on the second insulating substrate **721** so as to enhance contrast ratio (C/R). In addition, a second transparent electrode **724** is formed on the entire surface of the second insulating substrate on which the RGB color filter **722** is formed.

The first transparent electrode **714** of the first substrate **710** is arranged facing the second transparent electrode **724** of the second substrate **720**. A liquid crystal layer **730** is made of 90° twisted TN (Twisted Nematic) liquid crystal composition, and the liquid crystal **730** is disposed between the first substrate **710** and the second substrate **720**.

On an upper surface of the first LCD panel **750** is disposed a first polarizing plate **760**, and a second polarizing plate **770** is disposed on a lower surface of the first LCD panel **750**. Under the second polarizing plate **770** is disposed a transflective film **780** including at least two transparent layers, which have different refractivity index values from each other and are alternately stacked on the second polarizing plate **770**. The transflective film **780** partially reflects and partially transmits light incident thereto. Accordingly, the LCD device can display images through a reflection light path (R) and a transmission light path (T).

Referring again to FIG. **12**, the second display unit **200** includes a second LCD panel **250**, a third polarizing plate **260** and a fourth polarizing plate **270**. The second LCD panel includes a third substrate **210**, a fourth substrate **220** arranged facing the third substrate **210**, and a second liquid crystal layer **230** disposed between the third substrate **210** and the fourth substrate **220**. On an upper surface of the second LCD panel **250** is disposed a third polarizing plate **260**, and a fourth polarizing plate **270** is disposed on a lower surface of the second LCD panel **250**.

Although not shown in FIG. **12**, the second LCD panel **250** can be embodied same as the first LCD panel **750** of FIG. **13**.

A backlight **800** is disposed between the first and second display units **700, 200**. The backlight **800** generates light and provides the first and second display units **700, 200** with the generated light.

The backlight **800** includes a lamp unit **820**, a first light guiding member **820**, a second light guiding member **830**, and a luminance controlling member **840** disposed between the first and second light guiding members **820, 830**. The lamp unit **810** includes a lamp **811** for generating light, and a lamp reflector **812** for reflecting the light generated from the lamp **811** to provide the first and second light guiding members **820, 830** with the light generated from the lamp **811**. A part of the light generated from the lamp **811**, or the first light **L1**, is incident onto the first light guiding member **820**, and the other part of the light generated from the lamp **811**, or the second light **L2**, is incident onto the second light guiding member **830**.

The first light guiding member **820** includes four first side faces including a first light incident face **821**, a first light reflective-transmissive face **822** and a first light exiting face **823**. The first light exiting face **823** faces the first light reflective-transmissive face **822**.

The first light **L1** incident into the first light guiding member **820** through the first light incident face **821** is divided to proceed toward the first and the second display units **700, 200** by the following path. The first light guiding member **820** divides the first light **L1** to exit third and fourth lights **L3**, **L4**. The first light guiding member **820** exits the third light **L3** or a part of the first light **L1** toward the first display unit **700**, and exits the fourth light **L4** or the other part of the first light **L1** toward the second display unit **200**. Specifically, the third light **L3** includes light exiting directly from the first light exiting face **823** and light being reflected by the first light reflective-transmissive face **822** to exit through the first light exiting face **823**. The fourth light **L4** passes through the first light reflective-transmissive face **822** to proceed toward the second display unit **200**.

The second light guiding member **830** is disposed between the first and second display units **700, 200**, and more specifically is disposed in the vicinity of the first reflective-transmissive face **822**. The second light guiding member **830** includes four second side faces including a second light incident face **831** onto which the second light **L2** is incident, a second light reflective-transmissive face **832** and a second light exiting face **833**. The second light exiting face **833** faces the second light reflective-transmissive face **832**.

The second light **L2** incident into the second light guiding member **830** through the second light incident face **831** is divided to proceed toward the first and second display units **700, 200** by the following path. The second light guiding member **830** divides the second light **L2** to exit fifth and sixth lights **L5, L6**. The second light guiding member **830** exits the sixth light **L6** or a part of the second light **L2** toward the first display unit **700**, and exits the fifth light **L5** or the other part of the second light **L2** toward the second display unit **200**. Specifically, the fifth light **L5** includes light exiting directly from the second light exiting face **833** and light being reflected by the second light reflective-transmissive face **832** to exit through the second light exiting face **833**. The sixth light **L6** passes through the second light reflective-transmissive face **832** to proceed toward the first display unit **700**.

A luminance controlling member **840** is installed between the first light guiding member **820** and the second light guiding member **830**. The luminance controlling member **840** may have a sheet shape or a plate shape thicker than the sheet shape, and is made of, for example, polyethylene terephthalate (PET) treated by foaming agent.

The fourth light **L4**, which passes through the first light reflective-transmissive face **822** of the first light guiding member **820**, and the sixth light **L6**, which passes through the second light reflective-transmissive face **832** of the second light guiding member **830**, reach the luminance controlling member **840**. The luminance controlling member **840** reflects a part of the fourth light **L4** to provide the first display unit **700** with the reflected part of the fourth light **L4** through the first light guiding member **820**, and transmits the other part of the fourth light **L4** to provide the second display unit **200** with the other part of the fourth light **L4**. In addition, the luminance controlling member **840** reflects a part of the sixth light **L6** to provide the second display unit **200** with the reflected part of the sixth light **L6** through the second light guiding member **830**, and transmits the other part of the sixth light **L6** to provide the first display unit **700** with the other part of the sixth light **L6**.

A first luminance at the first display unit **700** and a second luminance at the second display unit **200** are precisely controlled by controlling the light reflectivity and the light transmissivity of the luminance controlling member **840**. Thus, a ratio of the first luminance to the second luminance can be precisely controlled by controlling the light reflectivity and the light transmissivity of the luminance controlling member **840**.

In this embodiment, the first light guiding member **820** is a flat type light guiding plate, in which a vertical distance between the first light reflective-transmissive face **822** and the first light exiting face **823** is substantially uniform. The second light guiding member **830** is also a flat type light guiding plate. However, the first and second light guiding members may have a wedge shape, in which the vertical distance between the light reflective-transmissive face and the light exiting face varies gradually.

FIG. **14** is a schematic view showing a structure of the liquid crystal display device of FIG. **12** further including light reflection patterns and optical sheets.

Referring to FIG. **14**, a first light reflection pattern ***822a*** is formed on the first reflective-transmissive face **822** of the first light guiding member **820**, and a second light reflection pattern ***832a*** is formed on the second reflective-transmissive face **832** of the second light guiding member **830**. For example, the first and second light reflection patterns ***822a***, ***832a*** include a plurality of dots arranged in a matrix shape.

The size of the respective dots of the first light reflection pattern ***822a*** successively increases in proportion to the distance between a dot of the first light reflection pattern ***822a*** and the first light incident face **821**. The size of the respective dots of the second light reflection pattern ***832a*** successively increases in proportion to the distance between a dot of the second light reflection pattern ***832a*** and the second light incident face **831**.

On the other hand, as shown in FIG. **14**, the backlight **800** further includes a first optical sheet **850** and a second optical sheet **860**. Specifically, the first optical sheet **850** is installed between the first display unit **700** and the first light exiting face **823**, and the second optical sheet **860** is installed between the second display unit **200** and the second light exiting face **833**.

The first optical sheet **850** enhances a viewing angle of a part of the third light L**3** and a part of the fourth light L**4**, and diffuses the part of the third light L**3** and the part of the fourth light L**4** so as to provide a uniform luminance distribution. The second optical sheet **860** enhances a viewing angle of a part of the fifth light L**5** and a part of the sixth light L**6**, and diffuses the part of the fifth light L**5** and the part of the sixth light L**6** so as to provide a uniform luminance distribution.

FIG. **15** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention.

Referring to FIG. **15**, an LCD device **1200** includes a first display unit **700**, a second display unit **1000** having a different size from the first display unit **700**, and a backlight **1100** disposed between the first and second display units **700, 1000**.

In this embodiment, a first display area of the first display unit **700** is larger than a second display area of the second display unit **1000**, and the first and second light guiding members **1120, 1130** each have a size fit to the first and the second display areas, respectively. The surface area of the first light guiding member **1120** is larger than that of the second light guiding member **1130**. In another embodiment, however, the first display area of the first display unit may be smaller than the second display area of the second display unit.

A luminance controlling member **1140** is disposed between the first and second light guiding members **1120, 1130**. The surface area of the luminance controlling member **1140** corresponds in its size to that of the first light guiding member **1120**, or corresponds to the largest one of the surface areas of the first and second light guiding members **1120, 1130**.

As shown in FIG. **15**, a first light reflection pattern **1122***a* is formed on a first reflective-transmissive face **1122** of the first light guiding member **1120**, and a second light reflection pattern **1132***a* is formed on the second reflective-transmissive face **1132** of the second light guiding member **1130**. In this embodiment, the first and second light reflection patterns **1122***a*, **1132***a* each include a plurality of dots arranged in a matrix shape. Since the surface area of the first light guiding member **1120** is larger than that of the second light guiding member **1130**, a configuration of the first light reflection pattern **1122***a* formed on the first reflective-transmissive face **1122** differs from the configuration of the second light reflection pattern **1132***a* formed on the second reflective-transmissive face **1132**.

For example, the size of the respective dots of the first (or second) light reflection pattern **1122***a* (**1132***a*) successively increases in proportion to the distance between a dot of the first (or second) light reflection pattern **1122***a* (**1132***a*) and a first (or second) light incident face **1121** (**1131**), but the size of the respective dots of the first light reflection pattern **1122***a* differs from the size of the respective dots of the second light reflection pattern **1132***a*. In other words, the dots of the second reflection pattern **1132***a* have sizes with a higher ratio of a size change to a unit distance change than those of the dots of the first reflection pattern **1122***a*.

Although not shown in FIG. **15**, the backlight **1100** may further include a first optical sheet and a second optical sheet. The first optical sheet may be installed between the first display unit **700** and the first light exiting face **1123**, and the second optical sheet may be installed between the second display unit **1000** and the second light exiting face **1133**. Preferably, the surface areas of the first and second optical sheets are in their size to those of the first and second light guiding members **1120, 1130**, respectively.

FIG. **16** is a sectional view showing a liquid crystal display device according to another exemplary embodiment of the present invention.

Referring to FIG. **16**, an LCD device includes a first display unit **700**, a second display unit **1300**, and a backlight **800** disposed between the first and second display units **700, 1300**.

The first display unit **700** includes a first LCD panel **750**, a first polarizing plate **760**, a second polarizing plate **770** and a first transflective film **780**. The second display unit **1300** includes a second LCD panel **1350**, a third polarizing plate **1360**, a fourth polarizing plate **1370** and a second transflective film **1380**.

Under the second polarizing plate **770**, or between the second polarizing plate **770** and the backlight **800**, is disposed a first transflective film **780** including at least two transparent layers having different refractivity index values from each other, i.e., a first layer and a second layer alternately stacked to form more than or equal to two layers. The first transflective film **780** partially reflects and partially transmits light incident thereto. Accordingly, the first display unit **700** displays images using the reflected light and the transmitted light.

Between the third polarizing plate **1360** and the backlight **800**, is disposed a second transflective film **1380** including at least two transparent layers having different refractivity index values from each other, i.e., a first layer and a second layer alternately stacked to form more than or equal to two layers. The second transflective film **1380** partially reflects and partially transmits light incident thereto. Accordingly, the second display unit **1300** displays images using the reflected light and the transmitted light.

While the present invention has been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A liquid crystal display device comprising:

a first display unit including:

a first liquid crystal display panel having a first substrate, a second substrate and a first liquid crystal layer between the first and second substrates, and

a transflective film disposed under the first liquid crystal display panel, the transflective film having a plurality of layers in which a first layer and a second layer each having a different refractivity index are alternately stacked, so that the transflective film partially reflects and partially transmits an incident light incident onto the transflective film;

a second display unit including a second liquid crystal display panel having a third substrate, a fourth substrate and a second liquid crystal layer between the third and fourth substrates; and

a light supplying unit disposed between the first and second display units, the light supplying unit generating a first light to provide the first display unit with a first part of the first light and the second display unit with a second part of the first light, and the light supplying unit controlling an amount of the first and second parts of the first light to regulate a contrast ratio of a luminance between the first and second display units.

2. The liquid crystal display device of claim **1**, wherein the first display unit further includes a first polarizing plate disposed on the first liquid crystal display panel and a second polarizing plate disposed between the first liquid crystal display panel and the transflective film, and the transflective film is integrally formed with the second polarizing plate.

3. The liquid crystal display device of claim **1**, wherein the first display unit further includes a first polarizing plate disposed on the first liquid crystal display panel and a second polarizing plate disposed between the first liquid crystal display panel and the transflective film, and the transflective film is formed separate from the second polarizing plate to have a sheet shape.

4. The liquid crystal display device of claim **1**, wherein the transflective film has an anisotropy characteristic having transmissivity and reflectivity varying depending on a polarized state and a direction of the incident light.

5. The liquid crystal display device of claim **4**, wherein when the transflective film has a film thickness in z-direction and a film plane in x-y plane parallel with a surface of the transflective film, the first layer and the second layer respectively have three main refractive indexes of n_x, n_y and n_z that satisfy the following relationships:

$$n1_x=n1_z\neq n1_y;$$

$$n2_x=n2_y=n2_z;$$

$$n1_x\neq n2_x;$$

$$n1_y\neq n2_y;\text{ and}$$

$$|n1_x-n2_x|<|n1_y-n2_y|$$

in which n1*x*, n1*y* and n1*z* denote main refractive indexes of the first layer in x-direction, y-direction and z-direction, respectively, and n2*x*, n2*y* and n2*z* denote main refractive indexes of the second layer in x-direction, y-direction and z-direction, respectively.

6. The liquid crystal display device of claim **1**, wherein the transflective film has isotropic transmission and reflection characteristics independent of a polarized state and a direction of the incident light.

7. The liquid crystal display device of claim **6**, wherein when the transflective film has a film thickness in z-direction and a film plane in x-y plane parallel with a surface of the transflective film, the first layer and the second layer respectively have three main refractive indexes of n_x, n_y and n_z that satisfy the following relationships:

$$n1_x=n1_y=n1_z;\text{ and}$$

$$n2_x=n2_y=n2_z\neq n1_z.$$

in which n1*x*, n1*y* and n1*z* denote main refractive indexes of the first layer in x-direction, y-direction and z-direction, respectively, and n2*x*, n2*y* and n2*z* denote main refractive indexes of the second layer in x-direction, y-direction and z-direction, respectively.

8. The liquid crystal display device of claim **1**, wherein a reflection path and a transmission path are provided in the first display unit, light traveling through the reflection path being incident onto a front face of the first liquid crystal display panel and reflected by the transflective film toward the first liquid crystal display panel to exit through the front face of the first liquid crystal display panel, and light traveling through the transmission path being incident onto a rear face of the first liquid crystal display panel from the light supplying unit after passing through the transflective film to exit through the first liquid crystal display panel.

9. The liquid crystal display device of claim **1**, wherein the transflective film comprises a first transflective layer and a second transflective layer, the first transflective layer having transmissivity and reflectivity varying depending on a polarized state and a direction of the incident light, the second transflective layer having isotropic transmission and reflection characteristics independent of the polarized state and the direction of the incident light.

10. The liquid crystal display device of claim **1**, wherein the first display unit further includes a light scattering layer.

11. The liquid crystal display device of claim **10**, wherein the first display unit further includes a first polarizing plate disposed on the first liquid crystal display panel and a second polarizing plate disposed between the first liquid crystal display panel and the transflective film, and the light scattering layer is disposed between the first substrate and the second polarizing plate.

12. The liquid crystal display device of claim **10**, wherein the first display unit further includes a first polarizing plate disposed on the first liquid crystal display panel and a second polarizing plate disposed between the first liquid crystal display panel and the transflective film, and the light scattering layer is disposed between the second substrate and the first polarizing plate.

13. The liquid crystal display device of claim **10**, wherein the first display unit further includes a first polarizing plate disposed on the first liquid crystal display panel and a second polarizing plate disposed between the first liquid crystal display panel and the transflective film, and the light scattering layer is disposed between the second polarizing plate and the transflective film.

14. The liquid crystal display device of claim **1**, wherein the transflective film comprises two anisotropic transflective layers each having a transmissivity and a reflectivity that vary according to a polarized state and a direction of the incident light.

15. The liquid crystal display device of claim **1**, wherein the second display unit further includes:

a third polarizing plate disposed on a first surface of the second liquid crystal display panel; and

a fourth polarizing plate disposed on a second surface of the second liquid crystal display panel.

16. The liquid crystal display device of claim **1**, wherein the light supplying unit comprises:

a light source for generating the first light;

a light guiding member for receiving the first light, providing the first display unit with the first part of the first light as a second light, and providing the second display unit with the second part of the first light as a third light; and

a luminance controlling member for reflecting a first part of the third light and transmitting a second part of the third light to control the contrast ratio of the luminance between the first and the second display units.

17. The liquid crystal display device of claim **16**, wherein the light guiding member comprises:

a light incident face for receiving the first light;

a light reflective-transmissive face for reflecting the second light toward the first display unit and transmitting the third light toward the second display unit; and

a light exiting face, being opposite to the light reflective-transmissive face, for exiting the second light.

18. The liquid crystal display device of claim **17**, wherein a light reflection pattern having a plurality of dots is formed on the light reflecive-transmissive face, and sizes of the dots are different such that a dot farther apart from the light

incident face is larger than a dot closer to the light incident face in proportion to a distance between a corresponding dot and the light incident face.

19. The liquid crystal display device of claim **17**, further comprising an optical sheet for changing an optical distribution of the second light so as to enhance an optical characteristic of the second light, the optical sheet being disposed between the light guiding member and the transflective film.

20. The liquid crystal display device of claim **16**, wherein the luminance controlling member has a sheet shape.

21. The liquid crystal display device of claim **1**, wherein the luminance measured at the first display unit is higher than the luminance measured at the second display unit.

22. The liquid crystal display device of claim **1**, wherein a surface area of the first liquid crystal display panel has a size substantially equal to a surface area of the second liquid crystal display panel.

23. The liquid crystal display device of claim **1**, wherein a surface area of the first liquid crystal display panel is larger than a surface area of the second liquid crystal display panel.

24. A liquid crystal display device comprising:

a first display unit including:

a first liquid crystal display panel having a first substrate, a second substrate and a first liquid crystal layer disposed between the first and second substrates, and

a first transflective film disposed under the first liquid crystal display panel, the first transflective film having a plurality of layers in which a first layer and a second layer each having a different refractivity index are alternately stacked, so that the first transflective film partially reflects and partially transmits a first incident light incident onto the first transflective film;

a second display unit including a second liquid crystal display panel having a third substrate, a fourth substrate and a second liquid crystal layer disposed between the third and fourth substrates; and

a light supplying unit disposed between the first and second display units, the light supplying unit dividing a first light, which is a first part of a light generated from an light source, into a third light and a fourth light to provide the first and second display units with the third and fourth light, respectively, and dividing a second light, which is a second part of the light generated from the light source, into a fifth light and a sixth light to provide the second and first display units with the fifth and sixth light, respectively, the light supplying unit controlling an amount of the third, fourth, fifth and sixth light to regulate a contrast ratio of a luminance between the first and second display units.

25. The liquid crystal display device of claim **24**, wherein at least one switching device and a transparent pixel electrode electrically connected to the switching device are formed on the first substrate, and a transparent common electrode facing the transparent pixel electrode is formed on the second substrate.

26. The liquid crystal display device of claim **25**, wherein the switching device is a thin film transistor.

27. The liquid crystal display device of claim **24**, wherein the light supplying unit includes:

the light source for generating the light;

a first light guiding member for receiving the first light, for providing the first display unit with the third light, and for transmitting the fourth light toward the second display unit;

a second light guiding member for receiving the second light, for providing the second display unit with the fifth light, and for transmitting the sixth light toward the first display unit;

an luminance controlling member, disposed between the first and second display units, for reflecting a first part of the fourth light toward the first display unit, for transmitting a second part of the fourth light toward the second display unit, for transmitting a first part of the sixth light toward the first display unit, and for reflecting a second part of the sixth light toward the second display unit, to thereby control the contrast ratio of the luminance between the first and second display units.

28. The liquid crystal display device of claim **27**, wherein the first light guiding member comprises:

a first incident face for receiving the first light;

a first light reflective-transmissive face for reflecting the third light toward the first display unit and for transmitting the fourth light toward the second display unit; and

a first light exiting face, being opposite to the light reflective-transmissive face, for exiting the third light, and

the second light guiding member comprises:

a second incident face for receiving the second light;

a second light reflective-transmissive face for reflecting the fifth light toward the second display unit and for transmitting the sixth light toward the first display unit; and

a second light exiting face, being opposite to the second light reflective-transmissive face, for exiting the fifth light.

29. The liquid crystal display device of claim **28**, wherein a first light reflection pattern having a plurality of first dots is formed on the first light reflecive-transmissive face, a second light reflection pattern having a plurality of second dots is formed on the second light reflecive-transmissive face, wherein the first dots have different sizes such that the farther a first dot is apart from the first light incident face, the larger the first dot is in proportion to a distance between the first dot and the first light incident face, and the second dots have different sizes such that the farther a second dot is apart from the second light incident face, the larger the second dot is in proportion to a distance between the second dot and the second light incident face.

30. The liquid crystal display device of claim **29**, wherein the first light guiding member has a surface area larger than that of the second light guiding member, the second dots have sizes with a higher ratio of a size change to a unit distance change than those of the first dots.

31. The liquid crystal display device of claim **24**, wherein a surface area of the first liquid crystal display panel has a size substantially equal to that of the second liquid crystal display panel.

32. The liquid crystal display device of claim **24**, wherein the first liquid crystal display panel has a surface area larger than that of the second liquid crystal display panel.

33. The liquid crystal display device of claim **24**, wherein the second display unit further includes a second transflective film disposed between the second liquid crystal display panel and the light supplying unit, and the second transflective film has a plurality of layers in which a third layer and a fourth layer each having a different refractivity index are alternately stacked, so that the second transflective film partially reflects and partially transmits a second incident light incident onto the second transflective film.

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